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SCIENTIFIC REPORTS

OF THE

INDIAN AGRICULTURAL RESEARCH INSTITUTE FOR THE YEAR ENDED 30TH JUNE, 1951.

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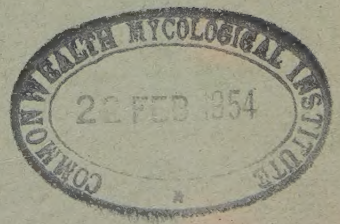

Errata slip for the Annual Scientific Report of the Indian Agricultural Research Institute, New Delhi, for the year ended 30th June, 1951.

For "Herbria" occurring in the table of contents under Item 3(v) substitute "Herbaria" and insert "of" after "Division" in Nos. 2-5 under Part II.

For "(.)" and "T" occurring in page 1, para. 4, line 5 after the word "Ranchi" substitute "(,)" and "t" respectively.

After "80 lbs." occurring in page 3, para. 1, line 3 insert "N".

For "institute" occurring in page 4, para. 6, line 8 substitute "Institute".

For "berseam" occurring in page 4, para. 7, line 6 substitute "berseem".

For "experiments" occurring in page 5, para. 1, line 1 substitute "experiment".

For "Varities" occurring in page 5, para. 4, line 1 substitute "Varieties".

For "entirly" occurring in page 6, para. 7, line 3 substitute "entirely".

For "Siou" occurring in page 8, para. 5, line 3 substitute "Sioux".

For "conspicuous" occurring in page 8, para. 5, line 3 substitute "conspicuously".

For 'Indian" occurring in page. 8, para 6, line 3 substitute "Indiana".

For "Hydbrid" occurring in page 8, para. 7, line 1 substitute "Hybrid".

For "autoterraploid" occurring in page 8, para. 8, line 1 substitute "autotetraploid".

For "damaged" occurring in page 8, para. 8, line 5 substitute "damage".

For "gain" occurring in page 8, para. 11, line 2 substitute "grain".

For "contained" occurring in page 8, para. 11, line 3 substitute "obtained".

For "as" occurring in page 9, para. 7, line 4 substitute "an".

For "insculpta" occurring in page 10, para. 1, line 3 substitute "inscuepta".

For "session" occurring in page 11, para. 8, line 6 substitute "season".

For "Trichorramma" occurring in page 12, para. 8, line 1 substitute "Trichogramma".

For "*Hiegoglyphus nigrorepleuts*" occurring in page 12, para 9, line 1 substitute "*Hieroglyphus nigrorepletus*".

In page 18 para. 5, line 2 insert "a" between "be" and "member".

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For "Membran" occurring in page 13, para. 4, line 4 substitute "Membrane".

For "eighbourhood" occurring in page 13, para. 9, line 2 substitute "neighbourhood".

For "red" occurring in page 14, para. 4, line 4 substitute "Red".

For "87" occurring in page 14, para. 5, line 1 substitute "37".

For "Aggrosan" occurring in page 14, para. 7, line 2 substitute "Agrosan".

For "*atroseitica*" occurring in page 15, para. 1, line 3 substitute "*atroseptica*".

For "40" occurring in page 15, para. 1, line 4 substitute "4".

For "*Nitotiana*" occurring in page 15, para. 2, line 2 substitute "*Nicotiana*".

For "*tobaci*" occurring in page 15, para. 5, line 2 substitute "*tabaci*".

For "develope" occurring in page 16, para. 1, line 2 substitute "develop".

For "1938" occurring in page 16, para. 9, line 3 substitute "1398".

For "the" occurring in page 18, para. 4, line 1 substitute "a".

For "*Haracleum*" occurring in page 18, para. 4, line 21 substitute "*Heracleum*".

For "Ukhla" occurring in page 19, para. 1, line 4 substitute "Okhla".

For "Matseh" occurring in page 19, para. 2, line 13 substitute "Motsch".

For "423" occurring in page 19, para. 4, line 1 substitute "432".

Insert "and" after (I. C. S. C.) occurring in page 20, para. 1, line 2.

For "Indie" occurring in page 21, para. 3, line 2 substitute "Indiae".

For "Exsicati" occurring in page 21, para. 3, line 3 substitute "exciccati".

For "Directors" occurring in page 22, para. 3, line 3 substitute "Director".

For "Barley MC" occurring in page 23, under IV(a), line 2 substitute "Barley C".

For "t" occurring in page 23, under IV(c), line 1 substitute "to".

For "buge" occurring in page 23, under IV(c), line 2 substitute "bug".

For "ustard" occurring in page 23, under IV(c), line 2 substitute "mustard".

For "to" occurring in page 23, para. 10, line 1 substitute "on".

For "entires" occurring in page 23, para. 11, line 2 substitute "entries".

For "VIII" occurring in page 24, para. 3, line 1 substitute "VII" and delete the programme of work under VII.

For "this is" occurring in page 25, para. 3, line 8 substitute "theses".

Before "Loyd" occurring in page 27, para. 4, line 11 insert "Mr.".

For "Sudy" occurring in page 31, para. 2, line 2 substitute "Study".

For "as" occurring in page 32, para. 6, line 2 substitute "lbs.".

Insert "11 over 5,000 lbs." in page 42, para. 6, line 7 after "6,000 lbs.".

For "economies" occurring in page 43, in the heading of para. 7 substitute "economics".

For "is" occurring in page 44, para. 2, line 1 substitute "are".

For "demonstrations" occurring in page 44, para. 5, line 2 substitute "Demonstrations".

For "(,)" occurring in page 44, para. 5, line 1 substitute "(.)".

For "ripe" occurring in page 44, para. 5, line 2 substitute "ripen".

For "cre" occurring in page 44, para. 9, line 2 substitute "acre".

For "inorganic" occurring in page 48, para. 1 (a) (i), line 2 substitute "in organic".

For "wich" occurring in page 48, para 1 (d), line 1 substitute "which".

For "whch" occurring in page 49, para. 2, line 1 substitute "which".

For "1, 973·68" occurring in page 49, para. 2, line 6 substitute "1973·88".

For "P_2O^4" occurring in page 51, para. 1, line 6 substitute "P_2O_5".

For "Varieal" occurring in page 52, para. 6, line 1 substitute "varietal".

For "mads" occurring in page 53, para. 2, line 5 substitute "mds".

Insert "Rs." in page 55, para. 4, line 1 before "36,302/-".

In page 57 transfer the bracket) from after 50-51 to after "PUSA" and delete "By" occurring above (Dr. N. Parthasarathy).

For "trails" occurring in page 57, para. 5, line 6 substitute "trials".

For "ninteen" occurring in page 57, para. 6, line 4 substitute "nineteen".

For "observation" occurring in page 58, para. 3, line 1 substitute "observations".

In page 58, para. 7, line 3 insert "been" after "have".

For "and" occurring in page 59, para. 4, line 3 substitute "of".

For "commercia" occurring in page 60, para. 3, line 4 substitute "commercial".

For "Davlin's" occurring in page 60, para. 3, line 5 substitute "Devlin's".

For "season" occurring in page 60, para. 4, line 2 substitute "seasons."

Insert "unlike" after "hybrids" occurring in page 60, para. 8, line 4

For "sessame" occurring in page 61, para. 2, lines 1 and 9 substitute "sesame".

Insert "more" before "marked" occurring in page 61, para. 2, line 4.

For "*Titicum*" occuring in page 61, para. 5, line 1 substitute "*Triticum*".

Insert "a" before "few" occurring in page 61, last para., line 3.

For "Abelmoshus" occurring in page 62, para. 2, line 2, substitute "Abelmoschus".

For "Station" occurring in page 63, para 4, line 6, substitute "Stations".

For "stages" occurring in page 64, para. 9, line 6, substitute "states".

For "ployploids" occurring" in page 65, para. 4, item 4, line 2, substitute "polyploids".

For "show" occurring in page 66, para. 4, line 1, substitute "showed".

For "he" occurring in page 66, para. 6, line 2, substitute "the".

For "1·35" occurring in page 66, para. 6, line 4, substitute "1·55".

For "*Prosapis*" occurring in page 66, para. 6, line 5, substitute "*Prosopis*".

For "*Crotaloria*" occurring in page 66, para. 6, line 6, snbstitute "*Crotalaria*".

Delete "to" occurring in page 67, para. 1, line 2, after the word "proved".

For "to" occurring in page 67, para. 6, line 3, substitude "of".

For "condiderable" in page 67, para. 6, line 4, substitute "considerable".

Delete "be" occurring in page 68, para. 1, line 1, after the first word "using".

Put more space between "e" and "a" of the word superphosphatea occurring in page 68, para. 3, line 2, to separate "a" as an article.

Insert "The results are awaited" after "conducted" occurring in page 69, para. 2, line 4.

Delete "in" after the word "down" occurring in page 70, para. 1, line 3.

For "and" occurring in page 70, para. 6, line 1, substitute "to".

For "even" occurring in page 71, para. 2, line 1, substitute "seven".

For "Soil" occurring in page 71, para. 6, line 3 substitute "Soils".

For "methods" occurring in page 71, para. 9, line 1, substitute "method".

For "alcoho" occurring in page 72, para. 2, line 2, substitute "alcohol".

For "basa" occurring in page 72, para. 2, line 1, substitute "best".

For "P_2O" occurring in page 73, para. 2, line 2, substitute "P205".

For "trearments" occurring in page 73, para. 5, line 1, substitute "treatments".

For "spectropgraphic" occurring in page 74, in item 2, line 1, substitute "spectrographic".

For "specrographic" occurring in page 74, in item 3, line 1, substitute "spectrographic".

For "PROGRAM" occurring in page 74, in the heading of Soil Chemistry, substitute "PROGRAMME".

For "Mineralogical" occurring in page 75, in item No. 33, substitute "Minerological".

For "Asm" occurring in page 76, in item (iii), line 1, substitute "Ashm".

Insert "×" between 4·0 mm and 1·5 mm occurring in page 78, para. 2, line 3.

For "thirdly" occurring in page 78, para. 6, line 7, substitute "third".

For "is" occurring in page 78, para. 6, line 8, substitute "in".

For "temeperature" occurring in page 79, para. 3, line 3, substitute "temperature".

For "cog" occurring in page 79, para. 6, line 1, substitute "Coq".

For "Orthopthra" occurring in page 80, para. 5, line 6, substitute "Orthoptera".

Delete bracket) occurring in page 82, para. 10, line 2, after VIII.

For "in" occurring in page 83, under 1 (a), substitute "on".

For "*cephalonic*" occurring in page 83, in item (ii), line 1, substitute "*cephalonica*".

Delete "By" occurring in page 83, above Dr. R. S. Vasudeva in the heading and put the name within brackets ( ).

For "strain" occurring in page 89, para. 4, line 1, substitute "strains".

For "were" occurring in page 89, para. 4, line 1, substitute "was".

For "Rod" occurring in page 91, para. 7, line 3, substitute "Rot".

Insert "as" after "reacted" in page 91, para. 8, line 8.

For "that" occurring in page 92, para. 7, line 7, substitute "those".

For "ethylialcohol" occurring in page 95, para. 6, line 6, substitute "ethylalcohol".

For "planting" occurring in page 96, para. 2, line 6, substitute "plating".

For "*Helminthosdporium*" occurring in page 96, para. 3, line 6 substitute "*Helminthosporium*".

For "elegnas" occurring in page 97, para. 7, last line, substitute "elegans".

For "*Trtopileus*" occurring in page 98, para. 4, line 1, substitute "*Tretopileus*".

For "India" occurring in the heading of item 19, page 98, substitute "Indiæ".

For "*tritci*" occurring in page 98, para. last, in 1(b), substitute "*tritici*".

For "Advice" occurring in page 99, para. under IV(b), line 1, substitute "advice".

Delete "to" occurring after "attended" in page 100, para. 5, line 3.

For "opration" occurring in page 100, para. 7, line 1, substitute "operations".

For "have" occurring after "cost" in page 102, para. 3, line 6, substitute "has".

Insert "this" after "by" occurring in page 103, para. 5, line 1.

For "in" occurring in page 103, para. 6, line 6, substitute "of".

For "division" and "Agriculture" occurring in page 103, para. 7, line 1, substitute "Division" and "Agricultural".

For "consultatious" occurring in page 103, para. 7, line 2, substitute "consultations".

For "trails" occurring in pages 104 and 105, paras. 1(a) and 4, lines 3 and 3 respectively, substitute "trials".

For "to" occurring in page 104, para. 1(b), line 5, substitute "at".

For "by" occurring in page 104, para. 1(b), line 5, substitute "to".

For "division" occurring in page 104, para. 3, line 1, substitute "Division".

For "trails" occurring in page 106, para. 5, line 2, substitute "trials".

For "Lal" and "950" occurring in page 109, against Asstt. Director, substitute "Pal" and "1950" respectively.

For "Bhanduri" occurring in page 109, against Cytogeneticist, substitute "Bhaduri".

For "Dr." occurring in para. 109, under "Agronomy" before "A. R. Khan", substitute "Shri" and delete "D.Sc.".

For "Raychaudhury" occurring in page 110, under "Soil Science & Agrl. Chemistry", substitute "Raychaudhuri".

After "Dr. R. V. Tambane" occurring in page 110, under "Soil Science and Agrl. Chemistry", insert "B. Ag." and delete "M.Sc.".

For "earning" occurring in page 112, under "Botany", against Serial No. 20, substitute "earing".

For "R. Gurbasavaraj" occurring in page No. 112, item 16, substitute "H. Gurbasavaraj".

For "Munder" occurring in page 113, against Serial No. 43, substitute "Mundkur".

For "Graminar" occurring in page 113, against Serial No. 49, substitute "Graminae".

For "Fungud" occurring in page 113, against Serial No. 51, substitute "Fungus".

For "Sandhu" occurring in page 116, against Serial No. 6, substitute "Sandhu".

For "*Furasium*" occurring in page 114, against Serial No. 54, substitute "*Fusarium*".

For "Chandani" occurring in page 117, para. 6, substitute "Chandnani".

For "Munjlal" occurring in page 117, para. 7, substitute "Munjal".

For "*Hamenoptera*" occurring in page 118, para. 4, substitute "*Hymenoptera*".

For "*Pertsicae*" occurring in page 118, para. 5, substitute "*persicae*".

For "Kukum' occurring in page 118, para. 7, substitute "Hukum".

For "Potatoe" occurring in page 118, in the last item, substitute "Potato".

For "D. T. T." occurring in page 119, in para. 4, line 1, substitute "D. D. T.".

For "Raychaudhury" occurring in page 119, paras. 11, 12 and 14, substitute "Raychoudhuri".

For "*Cuccumis*" occurring in page 119, para. 13, substitute "*Cucumis*".

For "*Mopastes*" occurring in page 120, in para. 8, line 1, substitute "*Molpastes*".

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PART I

REPORT OF THE DIRECTOR

I. INTRODUCTORY

Dr. B.P. Pal succeeded Dr. J. N. Mukherjee as Director of the Institute and took charge from 16th September 1950. Dr. N. Parthasarathy, Geneticist, was subsequently appointed as Head of the Division of Botany *vice* Dr. B. P. Pal. Mr. N. C. Pal, Registrar left the Institute to take up another appointment and Mr. J. M. Banerjee was appointed in his place.

The Central College of Agriculture was integrated with this Institute, on the recommendation of a Committee appointed for the purpose by the Government of India. In addition to the post-graduate training, the responsibility of teaching for the degree course in Agriculture (Delhi University) has thus devolved on this Institute as a result of this integration. A residential hostel to accommodate about 120 undergraduate students from the different states was under construction. As there is no separate building for the College, all the lectures and practical classes will be held in the different Divisions of this Institute.

Another important new activity of this Institute relates to the extension work in a number of villages in Delhi State. Several of the results achieved in this Institute as a result of research, have been practically demonstrated in the villages, and seeds of improved varieties of crops have been distributed to growers in these villages. A more detailed account of work done in this connection is given separately elsewhere in this report.

In the course of the development of this Institute the expansion of research in some commodities had resulted in the springing up of new daughter Institutes. The foundations of research in silk, lac, tobacco and potato in India were first laid, by this Institute which nursed the research activities, in these subjects till they were later taken over by the Bhagalpur Silk Institute, the Indian Lac Research Institute at Ranchi. The Central Tobacco Research Institute at Rajamundry and the Central Potato Research Institute at Patna, respectively. The Coimbatore Sugarcane Substation of this Institute, which is well-known for its valuable contribution to the improvement of sugarcane in India, has now become a separate Institute directly under the Ministry of Agriculture.

The Agricultural Substation at Karnal has been completely re-organised. A large portion of the area has been taken over by the Indian Council of Agricultural Research for the establishment of a Cattle-cum-Dairy Farm. Out of a total of 2154 acres at this Substation, only about 180 acres (which will later be increased to 250 acres) have been retained by this Institute for its experimental work. In addition to the important Tharparkar breed maintained at the Agricultural Substation, Karnal, a majority of the cows belonging to the famous Sahiwal dairy herd bred at this Institute, was transferred from Delhi to this new farm at Karnal.

2. SUMMARY OF MAIN RESULTS OF RESEARCH (1950-51)

Agronomy

Manures and Fertilizers

In an experiment, which is in its third cycle, on the *building up of soil fertility through organic manures and inorganic fertilizers* with and without legumes in rotation, it was found that inclusion of a legume, such as peas, in the rotation definitely increased the yields of the subsequent crops as compared to those crop rotations where a legume was not included. It was also found that, in the crop rotations in which a legume was not included, there was an appreciable deterioration in the yields of the non-legume crops in the rotation inspite of the latter crops being heavily manured. The rotations followed in this experiment were: wheat-maize-wheat-maize and wheat-maize-peas maize.

In a green-manuring experiment conducted with a view to studying the effect of time of burying in of sunnhemp, with or without fertilizers, on the subsequent wheat crop, it was observed that the ploughing in of an 8-week old crop of sunnhemp enhanced the yield of the following wheat crop. The application of superphosphate to the sunnhemp crop at the rate of 80 lbs. P_2O_5 per acre yielded the highest increase in wheat yield.

A comparison of the response of wheat to different doses of sulphate of ammonia, oil cake and F.Y.M. showed that the application of 80 lbs. N per acre as groundnut cake gave the highest yield.

Manurial experiment on potato with nitrogen and phosphorus.—The object of this experiment was to determine the optimum dose of nitrogen and phosphorus as also the best method of application of these fertilizers to the potato crop. Application of 120 lbs. N per acre gave a significantly higher yield of potatoes than when the doses applied were 40 and 80 lbs. N per acre. Placement of these fertilizers $2\frac{1}{2}$″ to the sides and 1″ below the tuber did not give any significant results.

Effect of application of low doses of phosphates to berseem on the building up of soil fertility.—The second cycle of this experiment commenced in the *rabi* of 1948-49. The treatments included 16,32 and 64 lbs. P_2O_5 per acre applied in the form of super phosphate F.Y.M. or their combinations. The manuring was done to berseem and a crop of cowpeas taken on the residues. In the yields of berseem fodder and seed, the treatments super alone, or in combinations, with F.Y.-M. at 64 lbs. 32 lbs. and 16 lbs. P_2O_5, gave significantly better results than the no-manure control. In cowpeas the treatments 64 lbs. P_2O_5 per acre in the form of super alone, or super mixed with F.Y.M., or F.Y.M. alone, gave significantly higher yields than others.

Effects of manuring berseem with or without potash, and its residual effect on the subsequent crops of maize, wheat and jowar.—No significant differences in the yields of the crops following berseem were noticeable. This indicated the absence of residual effect of any of the fertilizers or their combinations. In the yields of berseem, however, all phosphatic treatments gave significantly higher yields over the control.

In the experiment to determine the relative effects of different forms of phosphates on berseem, ammophos proved, again in the second year of the experiment, to be the best. Bonemeal and $(NH4)_2$ SO gave performances which were next in order of merit.

In the experiment on phosphatic manuring of berseem and on the effect of the application, either singly or in combination, of micronutrients like boron and molybdenum, the results confirmed those obtained last year that the major elements, such as phosphates and $(NH4)_2SO_4$, gave significantly high yields only in the first two cuttings whereas the micronutrients gave significant results in respect of all the cuttings. In seed yield, both major and micro-nutrients gave significantly high yield.

Cultural Experiments

In an experiment on a ratoon crop of sugarcane, it was found that cultivation of the soil with *desi* plough was as good as that with a tractor plough. No differences were noticeable when a full dose of 80 lbs. per acre was applied at planting or when a split-application of this quantity was done at planting and later, at the time of earthing up. Also no difference was noted when this fertilizer was applied either as broadcast or as placed, although there was a slight increase in yield in favour of the latter method of application.

Results obtained in a cultivation cum manurial experiment conducted on a loamy soil, in a rotation of maize-berseem-fallow wheat indicated that the depth of cultivation, with or without soil inversion had no effect on the yield of maize and wheat. Cultivation with *desi* plough appeared to give just as good results as those with ploughing with a tractor, a Victory plough or a tractor disc.

In an *experiment to study the effect of various doses of fertilizers, with or without basal dressing.*— On the yield of maize, it was observed that higher doses of nitrogen gave significantly higher yields ; thus 60 lbs. nitrogen per acre was superior to 40 lbs. N. per acre, which in turn was significant over 20 lbs. N. Spacing the rows 24″, 30″ or 36″ apart did not by itself result in any significant differences in yield. Also, placement of fertilizers or their broadcast application did not make for any significant difference.

Mixed Cropping—

In an experiment to study the relative utility of *mixed cropping* maize, *jowar* and bajra with cowpeas in different proportions over the individual cropping of these kharif crops showed that, in grain yield, pure maize and a 1 : 1 mixture of maize with cowpeas, manured with 10 tons of F.Y.M., gave yields superior to those obtained from unmanured maize or from a 3 : 1 mixture of maize and cowpeas. Cowpeas alone or a 1 : 1 mixture of cowpeas and maize gave yields superior to those given by a 3 : 2 mixture of cowpeas and maize or by a 1 : 1 mixture of *bajra* and cowpeas.

Rabi mixed cropping : Mixing of peas and linseed in different proportions with wheat (C. 518) did not improve the yield of the latter. In a similar experiment in which peas and lentil, in different proportions, were sown with wheat in different ways, the yield of wheat was not improved.

Mixed cropping of wheat and gram in different proportions and under different methods of sowing did not indicate any significant improvement in yield.

Varietal-cum-Manurial Trial—

In an experiment to study the response of different varieties of wheat (NP. 165, NP. 710 and NP. 771) to nitrogen, sowing dates and time of application of nitrogen, it was found that the effects of sowing dates on these varieties were not significant but the effect of nitrogen on yield was significant. Application of 40 lbs. N. per acre at sowing time gave the highest yield.

In another experiment on a varietal trial of N.P. and Punjab wheats, conducted with or without the application of fertilizers,varietal effect and interactions were found not to be statistically significant.

Varietal Trials

Varieties of the following crops showed superior performances in a series of varietal trials : flax, NP. 21 ; tobacco, S. 19 ; Sweet potato, T.S.T. white ; Sunnhemp, C. 12 ; Cotton, F. 216; Maize hybrids, Australian hybrids 431, 761 and 104 ; soyabean, Monetta and Clemson ; *Jowar*, Parbhani No. 5.

Grasses and Legumes

Bur clover (*Vicia sativa*) and *Dolichos* sp. showed profuse growth and covered the area planted to them. Among grasses, *Phalaris canariensis*, *Panicum antidotale* and a Napier grass collection from Jodhpur showed promise by giving very high yields of fodder.

Ley farming experiments: In Maize yield, manured plots in the continuous cereal rotation gave the highest yield; these yields were superior to those obtained under the manured, one-year ley *Dichanthium* or Rhodes mixture plots. In wheat yield, *Cenchrus* ley plots yielded significantly higher than the *Dicanthium* or Rhodes ley plots but not over continuous cereal rotation plots.

Seed mixtures: Association of legumes, such as *senji*, *Vicia* and peas, with oats or *Phalaris minor* significantly increased the percentage of protein in both the grasses. In this respect the proportions of the legumes at the rate of 1/3rd or 2/5th of the mixture were better than that at the rate of 1/4th of the mixture.

Kudzu Vine: The flowering was normal. Two hundred and sixty five pods were collected. Propagation by means of crowns was found to be very successful and easy to handle. Crowns sent to other states for trial also proved very successful.

Animal Husbandry and Management

The strength of the herd on 30th June, 1951, consisted of 36 cows, 1 stud bull, 22 young male stock, 7 young female stock, 7 bull calves and 3 cow calves, a total of 76 head. The reduction in the strength of the herd was due to the transfer of 229 head of cattle in the month of May, 1951, to the newly started Cattle-cum-Dairy Farm at Karnal. The normal strength of the herd now fixed is 42. Foot and Mouth disease appeared in the herd in May, 1951 and was responsible for the death of stud bull, Balwan No. 27. The net and overall averages of milk yield recorded during the year were 19·7 lbs. and 11·9 lbs. per cow as against 18·4 and 11·7 lbs. recorded last year. Out of 64 cows and heifers which completed their lactations during the year, 2 did over 9000 lbs., 12 over 7000 lbs., 14 over 6000 lbs. and 11 over 5000 lbs. of milk in a lactation period of 306 days. The work on line breeding, selection, precalving milking, calf rearing and early maturity experiments was continued. It was found this year also that the milk yield of the early maturity cows, as compared to the average yield of the cows in the respective lactations, was not lowered.

Agricultural Research Sub-Station, Karnal

The main activities of this sub-station during the year were principally (*i*) to carry out large-scale field experiments on different aspects of agronomic research, (*ii*) to multiply and distribute seeds of improved strains of field crops, and (*iii*) to improve the milch and draught qualities of the Tharparkar breed (dual purpose cattle), by line breeding. Since the reorganisation of the farm on 1st April, 1951, the entire Tharparkar herd so long maintained by this Institute and approximately 1973 acres of land, out of a total area of 2154 acres, were made over to the newly established Cattle-cum-Dairy Farm of the Indian Council of Agricultural Research. The research activity of this Sub-Station, under the direction of this institute, has since that date been suitably modified.

Crop Section

Manurial experiments: Manurial experiments with paddy were in progress. The results obtained from one of them showed that the paddy crop did not respond to nitrogenous manuring, in proportion to the doses of nitrogen applied to the crop, owing to the adverse effect of lodging which reduced the yield of grain. In the succeeding crop of berseem, the treatments indicated highly significant differences. Berseem gave superior yield when phosphate was applied either to the previous crop of paddy or directly to berseam.

In a green-manuring experiments, sunnhemp and cowpeas gave significantly higher yields of wheat than *guar*. In another experiment, the application of phosphate to the green manure crop of sunnhemp at the time of burying was found to give better yields of wheat than the application of phospate to the green manure crop at the time of sowing.

Varietal trials : Among the six varieties of sweet potato, F.A. 17a, white variety, gave the highest yield of tubers. In the wheat varietal trial N.P. 710, Punjab C-518, N.P. 760 and N. P. 720 gave the best results. The differences among these varieties were not statistically significaut. In the maize hybrids trial, Dixie 11, Ohio K-35, Dixie 18, North Carolina, Texas 18, U.S. hybrid 13, Indiana 210B, Ind. 416B, Iowa 4316 and Wisconsin 595 gave superior yields. Among themselves, the yields of these varieties did not differ significantly. The trial with Australian and Canadian maize hybrids showed that the Australian hybrids, Q. 431, Q. 716, and Q. 104 did not, among themselves, differ significantly in yield but that Q. 431 yielded significantly more than local white, Local Yellow and the Canadian hybrids. Local White was significantly superior in performance to all the Canadian hybrids. In the commercial maize hybrids trials, U. 80 yielded the highest.

Cultural experiments : Experiments to test the merits of seed bed preparation with tractor plough and bullock drawn inversion and non-inversion ploughs for paddy and wheat were in progress. In the case of paddy, tractor ploughing at the normal time, *i.e.*, before transplanting, gave the best results. The results obtained in the case of wheat did not show significant differences in respect of the effect of the different cultural operations.

Seed Supply : Seeds and other planting material of improved varities of a number of crops, including sugarcane, were supplied to indentors. The total quantity distributed was about 4,166 maunds.

Cattle Breeding Section

Milk Yield : The nett and overall averages recorded during the period from 1st July 1950 to 31st March 1951 were 18·6 and 13·1 lbs. per cow per day respectively. Among cows and heifers which completed their lactations, three cows did over 8,000 lbs., five cows over 7,000 lbs., eight cows and five heifers over 6,000 lbs. of milk in 306 days.

Calf rearing : 23 male calves with an average birth weight of 48·8 lbs. and 28 female calves with an average birth weight of 46·4 lbs. were born during the period under report. Their daily growth rates were 0·83 lbs. and 0·84 lbs. for male and female calves respectively upto the age of three months, 0·90 lb. and 1·00 lb. upto the age of six months and 0·77 and 0·95 lb. upto the age of eight months.

Sale of Cattle : During the period under report, 35 animals were sold to the Uttar Pradesh Government, 30 to the Bihar Government, 20 to the Army Headquarters, Western Command, New Delhi, eight to the Cattle Research Station, Jubbalpore and seven by public auction.

Agricultural Engineering

The research work of this Division had to be carried out on a restricted scale as the construction of the workshop and office buildings could not be undertaken during the year.

Tractor Operating costs and operational rates

A few wheeled type tractors were put into operation and tried in various field operations during the year. The costs of their operation and operational rates have been worked out.

Manure-Sieving Machine

Some modifications have been attempted on the manure sieving machine to improve its working. An engine of higher power was fitted up to the screen and after the modifications, it was taken to the Badli Dump for trial. The output of work was however found to be the same as that of a hand operated screen. The cost of production was also found to be higher than that obtained by manual labour.

Trial of Japanese Implements

Bullock-drawn Cultivator: A bullock-drawn three-tined cultivator, imported from Japan was tried and found suitable for preparing seed beds of crops like maize, cotton, etc., after the field had been ploughed by a mould board or *desi* plough. This has also been found suitable for making ridges in the farm, with the help of an additional attachment supplied with the implement. It can be used for weeding or inter-row cultivation as well. The average draft of the implement is 165 lbs. as against 160 lbs. of a Delhi bottom plough.

Grain-Screen: One of the four grain-screens that have been imported from Japan for finding out their suitability to Indian agriculture was tried and it was found that three operations were necessary to separate grains from undesirable elements by this machine. Even after the third operation, hand winnowing was necessary. The screen delivers 400 lbs. of grain per hour and the output is estimated to be 550 lbs. per hour if the screen is fed continuously.

Groundnut Decorticator

It was observed that there was an appreciable breakage of kernels when the machine was worked with cast iron pads. By the introduction of 3/8″ thick compressible type of rubber pads on the drum with a working speed of 350 R.P.M. the percentage of broken kernels was reduced to 2·78 as against 5·07 when operated by hand with iron pads.

Tractive efficiency of Farm Tractors

A test on the comparative tractive efficiency of two different tractors—one with a 20·7 Draw Bar Horse Power petrol engine and a wheel base of 70″ and the other with a 21·37 Draw Bar Horse Power engine and $88\frac{3}{4}$″ wheel base, was carried out. The test revealed that the tractors with larger diameter wheels and improved and deep treads are more efficient for farm operations, where working in loose and wet soils without sliding or slipping is necessary.

Trial of Dave's Seed Drill

A seed drill developed by Mr. Dave of Madhya Pradesh, was assembled and tried in the farm. The general performance of the drill was satisfactory. It gave an output of a quarter of an acre of sowing in 75 minutes with a seed rate of 41 seers of wheat per acre. This seed drill is considered to be an improvement over the existing ones as sowing by this machine is regular and the seed does not get bruised. There is also a saving of labour of one man who would otherwise have to go with the plough man, dropping seeds in the funnel.

Seed Drill for Small Grains

A four-row seed drill that was designed and fabricated at this Institute has given satisfactory performance during trial except that the seed rate per acre was found to be very low. Further work to improve the design and construction of this machine is in progress. The drill is built almost entirly of wood with the exception of shafts and gears. The seed selector wheels are also made of wood but require to be changed for each type and size of grain.

Indian Country Implements used alongwith a Tractor

A ' *bakhar* ' and a ' Bund Former ' were hitched behind a Fordson Major tractor and worked satisfactorily. The ' *bakhar* ' worked upto a depth of 4". The length of *bakhar* blade used was 4'—0" with 5" width and 1/4" thickness. The output was approximately an acre per hour. The Bund Former was fixed on the cultivator frame and worked successfully in a field already ploughed. More than one ' Bund Former ' can, at a time, be hitched on to a tractor.

Bullock drawn Harvesting Machine

An improved bullock drawn reaper, known as the Viking Oil Bath Reaper Model D.O., was tried simultaneously with an ordinary bullock drawn mower. The machine worked satisfactorily and gave a comparatively high output. No extra labour, except drivers, is required with this machine to clear the harvested crops from the track as the clearance is done in a mechanical process.

Plough Share Caps

Some plough share caps, made of chilled cast iron, were tried with 4 and 3 furrow Massey Harris ploughs hitched respectively on to D4 and Farmall ' H ' tractors. The life of a plough share cap has been found to be 60 hours, as against 50 hours (including flattening for three times) of the steel share on the Institute soils which contain 6 to 80 percent. of moisture. No wear and tear occurs on the steel shares when they are used with the caps on. The economics of the use of these caps is being worked out.

Botany.

Plant breeding and Genetics.

Breeding rust resistant wheat varieties : A number of promising selections has been made at Simla and Delhi; some of these are ready for performance trial. In a preliminary yield test at Simla, 4 selections were found to be particularly good yielders and rust resistant.

Trials of 12 wheat varieties of the newly-evolved wheats of the 700-series were conducted at 24 centres in India ; a number of these varieties have done very well, as regards both yield and tolerance to rusts, at a majority of centres. The Bihar and U. P. departments of agriculture and the Institute of Plant Industry, Indore, have already taken steps to multiply seeds of some of these varieties for distribution to growers. The varieties, N.P. 710 and 760, seeds of which were distributed to growers in and around Delhi under the Delhi Intensive Cultivation Scheme, gave very good performance.

The performance of 15 foreign wheats, including Saunders from Canada, was tested. None of them appeared particularly promising.

Some of the varieties, which were under study in connection with the preparation of the World Catalogue of Genetic Stocks for the F. A. O., appeared to be useful as breeding material, especially for resistance to lodging.

Work on breeding rust resistant wheats under the Coordinated Wheat Rust Control Scheme was started at the Botanical Substation, Pusa (Bihar).

Linseed : Trials of the 35 newly-evolved rust resistant linseeds were conducted at 11 centres in 6 states. In an attempt to breed early-maturing rust resistant linseeds for the Central Indian tract a number of promising selections has been made from crosses between the rust resistant strains and some early types from Bengal.

Rahar : In a yield trial experiment at Delhi, five selections including N. P. types 80 and 41, showed high degree of wilt resistance and gave very good yields.

Chilli : In trials conducted at Delhi, Karnal and Pusa, 3 pungent and 1 non-pungent varieties stood out as particularly high yielding.

Tobacco : Selections Nos. 19 and 20 of *hookah* tobacco (*Nicotiana rustica*) again showed superior performance. Gratifying results were obtained from S. 20, seedlings of which were distributed to growers around Delhi under the Delhi Intensive Cultivation Scheme.

Tomato : Among the newly-evolved early-maturing hybrids, Hyb. Nos. 3, 4, and 9 gave high early crop yields during November and showed high vitamin C content. Also in trials conducted at 20 centres in India, Hyb. Nos. 4 and 9 gave very good performance. Hybrid 6, possessing rich, attractive cherry type fruits, had 4·24 per cent. of sugar content besides high vitamin C content.

A large collection of indigenous and foreign tomato varieties was under study. The Australian variety—Q. 1, the Tasmanian varieties—Australian Earliana and Nystate, and the American varieties Siou, Devlin's Choice and Pearson, appeared conspicuous promising. The last two varieties, together with Desi Dickson, did remarkably well during the hot weather and gave fruits until the end of June.

Hybrid maize : This work is being done under an Indian Council of Agricultural Research Scheme. Forty double cross hybrids from the U.S.A., Canada and Australia were under trial at 20 centres in India. Of these, Dixie 11, U. S. 13, N. C. 27 and Indian 252A gave high yields at a majority of the centres.

Of the ten hybrids received from an American Commercial organisation, the United Hydbrid Growers Association, and tested at Delhi, Karnal and Simla, some did even better than all the other hybrids. Unfortunately, inbred lines of these, unlike those of the other hybrids, are not open to the public for use in hybrid seed production.

Cytology and Cytogenetics

Autopolyploidy : Work on selection for higher seed fertility in autoterraploid *Brassica*, linseed and sesame was continued. Promising *elite* bulk lines of tetraploids have been obtained in *toria* (*Brassica cam-pestris* var. *toria*) by the application of the pedigree mass selection method. Conclusive results could not be obtained from the preliminary yield trial experiment conducted with one such population because of damaged by locusts.

Sesamum : In a yield test conducted with 21 promising selections obtained by crossing cultivated *til* with a hardy wild species, *Sesamum prostatum* resistant to the phyllody disease, nine selections outyielded the best among the controls, by about 20 to 45 per cent ; some of these had high oil contents also. These selections will be tried next year at centres outside Delhi.

Bhindi : A new Indian wild species related to *bhindi*, *Abelmoschus tuberculatus* was studied and described. It has 2n=54 chromosomes as against 2n = 130 in the cultivated *bhindi*. The wild species is conspicuously resistant to the common virus diseases of the cultivated varieties and it is being utilised in breeding disease resistant varieties of the latter.

Crop Physiology

Study of drought resistance in wheat : A pot culture experiment conducted with 15 varieties confirmed last year's conclusions that varietal differences as regards spikelet number and gain size persisted under different conditions of drought. No conclusive results could, however, be contained

from the field experiment with the same varieties as moisture stress did not develop in the field owing presumably to rise in water table and, secondly, because the experimental crop lodged severely due to rainstorms in March.

Physiological analysis of factors governing yield in wheat : The results obtained in this experiment confirmed those of the previous years that the contribution of dry matter from photosynthesis in the ear to grain was significantly higher in the varieties N. P. 52 and N. P. 710 than in N. P. 165. The rates of yellowing of leaves, stem and ears in these varieties were measured ; none of them appeared to wholly explain the varietal differences observed. Further work is being done to elucidate these points.

Study of the influence of light and temperature on the growth and yield of wheat : In an experiment with 5 varieties sown on three different sowing dates, varietal differences in the response to late sowing were noticeable ; CPH 47 and Baluchistan 16 performed poorly in the late sowing, whereas C 591 performed better and the response of N. P. 165 and C 228 appeared to be rather neutral.

Physiological aspects of plant nutrition : Last year's observations were confirmed when, in an experiment conducted with 3 wheat varieties (N. P. 165, N. P. 710 and N. P. 52) and 3 levels of nitrogen, N. P. 710 absorbed the highest amount of nitrogen and utilised it least efficiently.

Plant hormones : The effect of dipping cut leaf tips of 4 varieties of wheat (N. P. 165, N. P. 52, C 228 and Agra Local) in different concentrations of indoleacetic acid was studied ; in Agra Local, ear and tiller production was stimulated and in N. P. 52, an increase in the number of fertile spikelets was observed.

The application of 2, 4-D to the soil caused a number of morphological abnormalities in the 10 wheat varieties grown on it. The observations did not confirm the existence of a correlation, which was indicated by the last year's results, between drought resistance and resistance to 2, 4-D, in the culture medium.

Lodging in wheat : An experiment was undertaken with 4 wheat varieties grown under different combinations of doses of nitrogen and potash. Nitrogen appeared to reduce the breaking strength of the culm, the dry weight per unit length of the basal internode and its silica content, whereas potassium seemed to induce as opposite effect. The top-weight of the culm, besides the three characters of the basal internode, appeared to be an important factor in determining resistance to lodging.

Systematic Botany and Plant Introduction

Plant Introduction : Four hundred and sixty two samples of plant material were received from several foreign countries during the year, bringing the total exotic collections under study to 3121 items. They were tested at Delhi and also at a number of other centres in different states in India.

The Chinese varieties of sweet potato, F. A. 17 and Tie-Shin-Tun, again gave excellent performances at a number of centres in India ; at Delhi, they yielded 100 percent. and 50 percent. more respectively than the best local variety. The varieties thus appear to have a wide range of adaptability in India. The Potato Yam (*Dioscorea*) yielded 146 mds. of tubers at Delhi and appears to be suitable for growing as a subsidiary food crop during April—November.

The other materials which appeared very promising include : (*a*) *Soybean* : E. C. 329-4, a Chinese bold-seeded bush variety maturing in about 90 days and two viny fodder varieties from Afghanistan. (*b*) *Cowpeas* : New Era—an early variety from Madras, a high yielding variety from Sudan, and the variety, Branco, from Brazil, appeared suitable for growing as a summer catch crop. (*c*) *Peas* : Zelka Marrowfats from Holland and Early Badger, an American variety. (*d*) *Mung* : U. P. type I a high yielding variety maturing in 60 days. (*e*) *Sunflower* : a hybrid, Advance, from Canada giving high

yield and oil content. (*f*) *Fodder legumes and grasses* : The perennial trailing legumes, *Indigofera endecaphylla* (Ceylon), *Desmodium intortum* (Guatemala) and *D. uncinatum* (Australia), a perennial trailing grass—*Bothriocloa insculpta* from Brazil and a high yielding strain of *Avena strigosa* from Uruguay.

Soil Science and Agricultural Chemistry

Agricultural Chemistry

Soaking seeds in nutrient solution before sowing : Experiments in pots were carried out on the effect of soaking seeds in nutrient solutions before sowing as an alternative method of application of fertilizers to soil. Increased yield over the control was observed with sunnhemp by pretreatment of the seeds with potassium phosphate (19 percent.), ammonium nitrate (15 percent.) and ammonium phosphate 34 percent.

Wild leguminous plants as green manure : It was reported last year that leaves of many wild leguminous plants are rich in nitrogen and as such could be profitably used for green manuring. Field experiments conducted this year showed that green manuring with leaves of *Prosopis juliflora*, *Tephrosia purpurea*, *Cassia occidentalis* and *Crotalaria medicoginea* resulted in an increase in the yield of wheat grain by 192-275 percent. over control, as compared to an increase by 180 percent. on burying berseem crop.

Conservation of human urine : Further experiments on the conservation and utilisation of human urine as manure showed that saw dust and tea waste have a remarkable capacity of absorbing urine and retaining all the nitrogen without loss, under moist conditions of storage.

Soil Chemistry

Phosphatic fertilisation of berseem : Raised plant experiments on the building up of soil fertility by phosphatic fertilisation of berseem confirmed the findings of previous years that it is possible to maintain a high level of fertility in the soil without application of artificial nitrogen or organic manure by following a legume rotation, like berseem-cowpea-wheat-cowpea. The beneficial effect was remarkably improved by the application of superphosphate to berseem.

Rapid methods of soil analysis : Rapid methods of soil analysis are being critically tested for application under Indian conditions.

Micronutrients

Top yellowing of gram : Top yellowing of gram is a disease common in Delhi and neighbouring localities and investigations on this line have been in progress in this Institute for the past several years. It has been found that the disease occurs due to lack of air-water balance in the root zone of the crop.

Soil Survey

Soil Survey : Soil Survey carried out during the year includes soil classification and soil mapping of the Institute farms at Delhi and Karnal, the study of black soils of Narmada Valley tract for their suitability for irrigation and a reconnaissance soil survey of Bhopal Sugar Industries Farm.

A very rapid reconnaissance soil survey of the Rann of Cutch was first carried out in April 1947. This year, a detailed survey of about 100 square miles was undertaken and a large number of profiles was examined. Further studies are in progress.

Physical Chemistry

Soil Colloids and Clay Minerals : Electrochemical properties of hydrogen clays prepared from horizon samples of a soil profile from the Institute farm at Karnal were studied. It was found that the clay fraction consists mainly of kaolinite but the top horizon also contains some montmorillonitic type of minerals. Kaolinite is also the predominant mineral in the clay fraction of the yellow Matasi soil profile from Labhandi, Madhya Pradesh.

Organic Chemistry

A rapid method of estimation of oil in oil seeds and oil cakes has been developed. About 0·5 gram of sample has been found to be sufficient for the estimation. Eight to ten samples of seeds can be analysed in duplicate in a working day of eight hours.

Soil Microbiology

Utilisation of indigenous phosphates : Pot experiments indicated that indigenous phosphates such as bone meal Trichi nodule and Singhbhum phosphate (Raka mine) could best be utilised by applying them to sunnhemp for the green manuring of wheat. The yield of wheat was as high as when superphosphate was applied under similar conditions.

Physics

Development of a rapid method of estimating nicotine in tobacco : A rapid spectrographic technique of estimating nicotine in tobacco has been developed. The method utilises as low as 0·1 gm of the tobacco sample.

Biochemistry

Utilisation of Mango seed kernel : Different varieties of mango seed kernel have been analysed for their chemical constituents such as protein fat carbohydrate fibre ash calcium phosphorus tannin etc. at different stages of ripening. The kernel is rich in carbohydrates fats and minerals. In protein content it is comparable to rice. The presence of tannin to the extent of 6 percent makes the kernels astringent. Certain methods of processing mango seed kernel have been worked out. By this processing mango seed kernel flour free from the taste of the astringent has been prepared.

Mango seed kernel is also a rich source of starch which is present in it to the extent of 50–60 percent on the basis of dry weight. The starch content has been found to be more in mature seed kernels. Different methods have been tried for the preparation of tannin free starch from this source. The starch thus prepared is white stains blue with iodine and the grains are 5–25 microns in size. It has been estimated that about 140,000 tons of starch may be made available every year from this source alone.

Quality of wheat varieties : A number of varieties of wheat evolved at this Institute have been analysed for protein vitamin B_2 and diastatic activity. These constituents have been found to vary considerably from variety to variety.

Chemical work at the Botanical Substation, Pusa

Work by the Chemistry Division at the Botanical Substation at Pusa (Bihar) was started this year. The lysimeter studies which were discontinued in 1934 with the transfer of the Institute to New Delhi were started again during the last *kharif season*. It has been decided to continue the same cropping system as followed previously during the period 1911-1934. The twelve " *Howards* " raised plots each with a surface area of one-thousandth of an acre have also been made ready for starting regular rotational-cum-manurial cropping experiments from the next *rabi* session.

Entomology

Parasitology

Mechanism of oviposition in Stenobracon deesae (Cam.):—The structure of the female genitalia ar the accessory organs and the mechanism of oviposition in *S. deesae* a potential parasite of the suga cane borer and the maize borer were investigated in detail. *An unrecorded Ptermodalid hyperparas on S. deesae (Cam.) was discovered.*

Biological control of Insect pests : *Bracon (Microbracon) chillonis Vier* : This parasite was found t attack the maize stem borer *Chilo zonellus* Swinh. Its breeding behaviour on *Corcyra* larvae is unde study.

Systematic Entomology

Lariidae (=Bruchidae) : Studies on the morphology of the external genitalia of this family o pulse beetles of India and Ceylon were completed and a comprehensive account has been sent fo publication.

Scelionidae : A new species of scelionid parasite parasitising on the eggs of *Hieroglyphus nigrore pletus* Bol. a serious pest of maize and jowar has been described.

Insect Vectors of Virus Diseases

Biology and life history of Trialeurodes ricini M : In the laboratory experiments the caste white-fly *T. ricini* proved to be an important transmitter of leaf-curl disease from diseased to health castor plants. The biology and life history of this species were therefore studied in detail with view to apply control measures against the pest.

Effect of insecticides on potato aphids : Spraying and dusting experiments conducted with DD + sulphur BHC Pyrethrum powder + Sulphur tobacco decoction and fish-oil-rosin-soap on *Myzu persicae* Sulz. and *Aphis rhamni Fonsce.* showed that gammexane (BHC) was the best insecticide as i gave a 91·87 percent. control of *M. persicae* while DDT + sulphur was the next best giving a 84·4 percent. control. Tobacco decoction gave the highest control *i.e.* 90·07 percent. in the case o *A. rhamni* while gamexane and fish oil soap proved to be the second and the third in order of mer giving 71·08 percent. and 54·67 percent. controls respectively.

Physiology of pupation in fruit flies : The ligature and injection experiments conducted with *Didacus* ciliatus (Loew.) showed that the pupation was controlled by a hormone and the 'critica period' when it is discharged in haemolymph of maggots was about 20 hours with extremes of 11 and 30 hours before pupation at 25°C. (77°F.) Wiesmanns Ring-gland secretes the pupation hormone i this fruit fly.

Ecology and Toxicology

Ecological studies on Trichorramma for constructing Biometer : It was found that lower humidity (35 percent.) at higher temperature (35°C) affects the parasite adversely.

Ecological studies on Hicgoglyphus nigronepleuts : This insect appears to have a definite specificit for food plant as the insects die of starvation if offered only *guar* or cotton leaves. Daily watering o pots containing eggs was found to be harmful for hatching of eggs. Also lower relative humidity (30 percent.) has been found to be adverse for the nymphs which cannot complete their nymphal perio under this humidity.

Insect epicuticle in relation to insecticidal action : A fairly strong correlation was observed between the nature of the Waxycovering on the insects' body and its susceptibility to contact insecticides.

Bioassy of stomach poisons : Some factors governing the efficacy of DDT and gamma-BHC as stomach poison were studied using *Euproctis lunata* larvae as test insects. Starvation appeared to decrease the resistance rather than increase the same as held by some earlier workers. Resistance also increased with body weight.

Effect of temperature on the susceptibility of mosquito larvae : The temperature coefficient of DDT action was found to be greatly influenced by the pre-treatment temperature.

Mode of action of insecticidal sprays : It was shown that both concentration as well as coverage affected the efficacy of an insecticidal spray. The possible causes of the immunity of insect eggs to the action of DDT were explored. It appeared that DDT as emulsion enters the chorion but not the membran within the chorion.

Mycology and Plant Pathology

Indian Type Culture Collection : The Indian Type Culture Collection now consists of 845 cultures. The collection continued to be member of the International Federation of Culture Collection which is linked to the UNESCO.

Plant Pathology

Wheat Rust : One hundred and four collections of rusts from different parts of the country, analysed for the study of the physiologic races showed that Races 21 and 42 of Black Rust, 63 and 20 of Brown Rust and 19 and A of Yellow Rust were predominant and widely distributed throughout the country. Other races met with were 40 and 34 of the Black 106, 103 and D of the Brown ; and 20, 31, A, E. and H. of the Yellow Rust. Studies on the role of wild grasses as collateral hosts of the wheat rust fungus revealed that a collection of *Andropogon* sp. affected with rust from Orissa yielded Race 34 of *Puccinia graminis tritici*, which is the first record of the occurrence of this race of rust in that region.

In the varietal resistance tests with a large number of wheat varieties their crosses and progenies 4 Simla hybrids and 4 exotic varieties proved resistant in the seedling stage to all the 9 Indian races of black rust ; one exotic variety proved resistant to all the 8 races of brown rust. When a mixture of all the 27 races of the three rusts was used as inoculum only one variety *E. 952* proved resistant out of the 50 cultures and 44 exotic varieties tested. In the adult stage, 36 exotic varieties, 9 hybrids and ten fixed hybrids were found to be resistant to all the nine Indian races of the Black rust; 31 exotic varieties reacted as resistant to all the eight races of Brown rust and 37 exotic varieties proved resistant to the ten races of the Yellow rust. With the mixture of all the 27 races of the three rusts 19 cultures belonging to six crosses in F3 generation proved resistant. Similarly out of the 124 cultures of the Delhi material four reacted as resistant.

Loose smut : Out of the 112 wheat varieties tested against a mixture of isolates L_1 and L_2 of the wheat Loose smut fungus 62 varieties did not show any infection. With L_1 isolate 58 varieties remained without infection. Fifty-two varieties failed to take infection either with mixture of L_1 and L_2 or L_4 isolate and may therefore be regarded as resistant.

Foot Rot of wheat observed to cause appreciable damage to the crop in the seedling stage in the eighbourhood of Delhi has been found to be caused by a *Fusarium* sp.

The ' Tundu ' *disease* has been found to be caused by *Corynbacterium tritici* (Hutchinson) Bergey *et al.* The presence of nematodes along with *Corynbacterium* was found to be essential to bring about the disease. The disease can be completely controlled by the removal of the nematode galls by floatation or sedimentation.

Barley Rust : A large number of barley varieties were tested for rust-resistance both in the seedling as well as in the adult stage. No variety was found to be resistant in the seedling stage to all the 9 races of Black rust ; barley veriety B. 216 reacted as resistant to all the 10 races of Yellow rust. In the adult resistant tests eight varieties proved to be resistant to all the nine races of Black rust and 61 resistant to all the ten races of Yellow rust.

The efficacy of Solar Treatment for the control of Loose smut of barley was confirmed.

Sugarcane Red Rot : Out of the 94 varieties including *Saccharam spontaneum* and other *Saccharum* spp. tested for Red Rot resistance 4 reacted as highly resistant and 59 as moderately resistant by the Standard Plug Method test and 18 varieties as highly resistant to nodal infection which is the chief mode of red Rot infection in nature. Thirty-two isolates of *Colletotrichum falcatum* Went were tested for the study of the physiologic forms of the Red Rot fungus. The light highly sporing isolates generally proved more virulent again. The experiments to study the relative susceptibility to Red Rot of cut canes and standing canes show that the results are not congruent in the two methods except in the case of highly susceptible varieties.

In the smut varietal resistance tests with 87 varieties at Karnal and 90 varieties at Delhi 26 varieties showed less than 5 percent. infection at both the places and may be regarded as highly resistant. *Linseed* : Most of the cultures of linseed tested for resistance against the four Indian physiologic races of the linseed rust proved immune or resistant both in the seedling and adult stages.

Pigeon pea : Three varieties (B.P. 41 C. 38-1-2 and D. 419-2-4) out of the twenty tested proved to be resistant to the wilt disease.

Fungicides

Studies on the relative efficacy of some common seed-dressing fungicides on germination stand and yield of maize wheat and barley showed that in the case of maize the treatments with Aggrosan GN Barbak Spergon and copper carbonate gave 72·9, 77·1, 77·5 and 75·8 per cent. germination as against 66·4 per cent. of the untreated control. The corresponding figures of yield were 94, 150, 114 and 114 lbs. respectively as compared to 108 lbs. of the Control.

Assessment of Damage

A reduction of 14·2 percent. and 19·6 percent. in the yield of wheat (Agra Local) due to Black rust infection was noted at 10 to 25 percent. and 40 to 60 percent. intensity of infection levels respectively the corresponding figures for N.P. 4 being 7·9 percent. and 13·1 percent. respectively. In the case of linseed it was found that with 40–45 percent. rust infection the losses in grain yield (on 1000—grain weight basis) varied from 3·1–21·4 percent. in six varieties under observation and with 75 percent. or over of infection the loss revealed was 10·5–32·5 percent. On the basis of total yield per 10 plants however the losses were observed to be much greater being 36–58·8 percent. with 75 percent. or over of rust infection. In the case of sugarcane a reduction in yield of 15·5 percent. in Co. 312 and 41·8 percent. in Co. 313 was observed as a result of smut infection when the setts were artificially infected at the time of planting. Greater loss in yield was however observed when setts from smutted canes were planted as is sometimes done by the cultivator ; the losses being 71 percent. in Co. 312 and 73·3 percent. in Co. 313. As regards the tomato leaf curl a reduction in yield of about 66 percent. due to the virus has been observed.

Studies on Soft Rot of potatoes have shown that *Erwinia* caratovora *E. aroideae* and *E. atroseptica* are capable of causing rot of potato and that *Bacillus mesentericus* is almost saprophytic. *E. caratovora* and *E. atroseitica* have been found to cause rotting of the potato tissue even at a low temperature of 40°C. under conditions of high humidity.

Virus Diseases

Mosaic disease of Bottelgourd caused by *Cucumis Virus* 2C is carried symptomlessly in *Datura stramonium Nitotiana tabacum N. tabacum* var. *White Burley Solanum nigrum* and *S. nodiflorum.* The infection is localised being confined to the inoculated region of the leaves only. The virus fails to infect *Lycopersicum esculentum* and *Capsicum annum.* It was also observed that leaf extracts of *Datura stramonium* and *Capsieum annuum* markedly inhibit the activity of the virus.

Attenuation of the Tomato Leafcurl virus (*Nicotiana Virus* 10) by passage through *Capsicum annuum* has been confirmed by repeated grafting tests. The attenuation of the virus by successive passage through tomato and *Datura* has also been observed. Field experiments on the control of Tomato Leafcurl indicate that the disease could be kept greatly under check by weekly spraying of the crop with Fish-oil-Rosin-Soap.

Phyllody in sannhemp was being studied to ascertain whether the disease is caused by the combined effect of mosaic and the leaf-curl viruses.

Enation Mosaic of *Hibiscus rosa-sinensis* and Leaf curl of *Bhindi* have been shown to be identical and the disease is transmitted to Bhindi by *Bemisia tobaci.*

Systematic Mycology

Five new species of *Pleosphaeropsis*, one of *Ascochyta*, one of *Septoria* and a new *Sphacelotheca* type of sugarcane smut have been described. Besides 54 specimens all of which are new records for India and some are new species were under study.

3. GENERAL FEATURES OF THE REPORT

Land and Buildings

On the recommendation of the Committee appointed by the Ministry of Food and Agriculture Government of India it was decided to reorganise the Agricultural Sub-station at Karnal and develop it into a Cattle-cum-Dairy Farm. Out of a total area of 2154 acres at the Karnal Sub-station, 1974 acres, including 285·5 acres taken over by the East Punjab Government, were transferred to the newly organised Cattle-cum-Dairy Farm. The Karnal Sub-station of the Indian Agricultural Research Institute now retains only about 180 acres, (later to be increased to 250 acres) for the purpose of continuing agricultural research work.

From the 241 acres of newly acquired *barani* land adjoining Todapur Village, from which 60 acres had been allotted into ten 6-acre " cultivator's holdings " last year, 10 acres have been ear-marked for the proposed buildings of the Indian Council of Agricultural Research.

With a view to facilitate training of students of the Central College of Agriculture, after the integration of the College with the Indian Agricultural Research Institute, some extensions and alterations of the existing buildings were taken up during the year under review.

During this period extension has also been made to the existing carpentery, smithy and engineering stores as well as the gas generating house.

To accommodate about 120 students of the Central College of Agriculture, after its integration with the Institute, a well designed residential hostel has been under construction on the land adjoining the recently constructed post-graduate hostel of this Institute.

The acute shortage of residential accommodation for the officers of this Institute has been slightly eased by the construction of seven ' C ' type quarters for class II officers.

To facilitate experimental research work as well as training of students, construction of two glass houses, one in the Botany and the other in the Mycology Division, have been taken up during the year under report.

(*ii*) *Library*

The Library, which is considered to be the biggest agricultural library in India, receives from different parts of the world, most of the important journals dealing with agriculture and the sciences basic to it. Shortage of space is now being felt in the library owing to the receipt of a large number of new books and periodicals and owing to the transfer of the library of the Central College of Agriculture to the Institute library. Thus the Institute library is now accommodating libraries of both the I.C.A.R. and the C. C. A. in the same building. The air conditioning unit of the library Stock Room which was installed 3 years ago but could not be put under operation due to unavailability of additional load of electric power has been put under service this year.

The total number of publications received in the library during the period under report, both by way of exchange as well as by purchase, was 2,995. Thirty-one new periodicals were added to the library during the year. Out of a total of 4,773 books issued from the library during the year, 1938 were sent out to scientific workers in the different Provinces and a few Universities.

During this period, the library supplied references to literature on various subjects to the Ministry of Agriculture, Indian Council of Agricultural Research, State Departments of Agriculture, Universities and to individual scientists. Mention may be made of the following :—

1. List of Literature on crop rotation.

2. List of Literature on phosphate fixation in soils.

3. List of references on viscosity of milk.

4. List of books on Colours.

5. List of literature on sugarcane in India with particular reference to Ecology, Geographical distribution and yield.

6. List of Literature on compost.

7. List of literature on fibre crops with special reference to India.

8. List of literature on the use of molasses for road making.

9. List of literature on Litchi.

10. List of Indian Scientific periodicals dealing with zoology, Botany and Agriculture with full particulars.

(*iii*) *Advisory Work*

The Institute, as in previous years, attended to a large number of requests for expert advice and help on agricultural matters from both official and non-official sources. These included the following :

At the request of Food and Agricultural Organisation of the United Nations, received through the Ministry of Food and Agriculture, Government of India, a survey of the ' terai grass-land ' area of the Uttar Pradesh was conducted during August-September, 1950 and a report was furnished to the F. A. O. of the United Nations through the Government of India.

At the request of the Rajasthan Underground Water Board the stock of their mechanical equipment was inspected and suggestions were given regarding the necessary accessories and new machinery and regarding an estimate of the expenditure involved.

To complete the survey work begun in 1947 the Soil Survey Party of the Institute visited the Banni areas of Cutch in February, 1951, with the object of (*i*) studying the soils of the Rann of Cutch, (*ii*) carrying out a soil survey of the Wagud tracts of Cutch and portions of the Little Rann of Cutch and (*iii*) carrying out the reconnaissance for gypsum and salt in the Adesar-Piprala section of the Rann of Cutch. A copy of the report has been submitted to the Ministry of Food and Agriculture, Government of India.

At the request of the Food Production and Development Commissioner, Government of Bihar, opinion was given in respect of the scheme on setting up a State Mechanised Farm of 4,000 acres at Islampur, District Purnea, Bihar.

Assistance was given to the chairman of the Damodar Valley Corporation in conducting a survey of the area to be irrigated from the *Kharif* of 1952 from the two reservoirs which are now under construction.

At the request of the Director, Central Potato Research Institute, Patna, a soil survey of the Institute Farm at Patna, covering an area of 25 acres, was carried out by the staff of the Chemistry Division of this Institute in May, 1951.

The various advisory and survey items attended to by the different Divisions of the Institute during the year under report are briefly mentioned below :—

The Division of Agronomy gave advice to state governments, individual farmers, dairy men, land owners and public organisations on different aspects of cultivation of crops *e.g.*, sugarcane, berseem, kudzu vine, special types of fodder and other grasses, etc., on the manuring of particular crops, breeding and feeding of livestock, etc. Information was also supplied to a number of correspondents on various subjects such as quantity of straw obtained in cereals, eradication of '*Kans* grass ', labour requirements for the cultivation of major crops in relation to the size of holdings, etc.

The Division of Agricultural Engineering gave technical advice to the Ministry of Food and Agriculture on matters including standardisation of tubes and tyres of farm tractors for purposes of import control and production in the country, collection of data on the standardisation of chaff cutting machines and blades, introduction and popularisation of agricultural implements of proved value within the country, compilation of the results of the tractor tests in different States and import control of tractors and power implements. Besides, many enquiries from the public and State Governments on the availability and suitability of various kinds of agricultural equipments and implements were answered.

The Division of Botany provided technical information on the number of advisory items to various correspondents both from India and abroad. These included supply of correct botanical names or vernacular names of 430 different plants with notes on their distribution and, in some cases, their uses; identification of 56 different specimens of plants, fruits, seeds, etc., testing of 4 samples of seeds for their purity and germination capacity. Correspondents were given advice on references to literature and supplied with notes on the cultivation of specific crops and on other topics. Mention may also be made of the following advisory items of work done by this Division. Dr. Hyland of Maryland, U. S. A. was given information on the research work done in India on mango. A note on the cultivation of pulses in India was sent to Dr. H. O. Singher, Ortho Research Foundation of Raritan, New Jersey, U. S. A. A note on the improvement of rice was sent to a correspondent in the West Indies. A note on the possible scope of collaborative work between Botany Division and the Agricultural Department of Madhya Pradesh was prepared for the use of the Agricultural Policy Committee of Madhya Pradesh. The Vegetable Specialist, Central Vegetable Breeding Farm, Kulu Valley, was supplied with a note on the methods of selfing of members of *Brassica spp.* with special reference to seed production in selected cabbages. A list of references on electro-culture was sent to Messrs. Kanji Parihar of Beawar. A note on the poisonous properties of certain grasses was prepared for Mr. D. D. Awashti of the National Botanic Garden, Lucknow. A list of avenue plants suitable for India was sent to Mr. K. S. V. Raman of the Damodar Valley Corporation. A number of specimens of commons weeds of crop fields around Delhi was identified for Major A. R. Tainsh of Messrs. Pest Control, Ltd., Cambridge (England) who visited Delhi. Some seeds sent by the Director, Malaria Institute, Delhi, and believed to possess anti-malarial properties, were identified as those of *Haracleum* Spp. belonging to the family *Umbelliferae.*

The Division of Soil Science and Agricultural Chemistry analysed a large number of samples received from various government agencies and from some private institutions. These samples included soil samples 307; manures and fertilizers, 39; milk, 99; water, 51; tomato, 40; oil-cakes 19 and other miscellaneous items, 65. The Division also supplied bacterial cultures for the inoculation of legume seeds to a number of interested persons. Bacterial cultures were also sent to the Damodar Valley Corporation with a view to grow sunnhemp and ' dhaincha ' at Hazaribagh. Special surveys were conducted and trials of manures and fertilizers carried out at the request of several institutions and individuals which included the following :

(*i*) A final report was submitted on manurial trials with 'Annapurna' a fertilizer preparation received through the Ministry of Food and Agriculture; (*ii*) A report on the soils of the farm of Bhopal

Sugar Industries Ltd., was sent to the Vice-Chairman, Indian Council of Agricultural Research ; (*iii*) A report was sent to the Indian Standards Institution after comparison of different methods of estimating free phosphoric acid in superphosphates ; (*iv*) A report on the improvement of the sewage-irrigated area near ' Ukhla ', Delhi, was sent to the Deputy Commissioner, Delhi State. The Division attended to a large number of enquiries and sent notes on different subjects to a number of organisations such as the Food and Agricultural Organisation of the U. N., various Central and State Government Departments etc. These included. Use of mint-waste containing copper hydrate, zinc, etc., for preparing fungicides and for correcting minor-element deficiencies in plants, to India Government Mint, Bombay ; fertilisers, manures and soil amendments in rice culture in India, to the F. A. O. Washington, U. S. A. ; use of mango seed karnel, to the All India Women's Food Council ; utilisation of paddy husk for composting, to Sarda Rice Mills, Mysore ; use of lime and inoculation of soil for growing legumes in acid soils, to Tea Estates (India) Ltd., Nilgiris.

The Division of Entomology received 37 parcels, containing 286 specimens for identification, from different places in India. They were all properly identified and reports were sent to the respective correspondent. Information was also supplied on various topics to different correspondents both from India and abroad. These included a brief note on the work done at this Institute on ' Insect flight ', to Prof. A. B. Hocking, Department of Agriculture, Alberta University, U. S. A. ; a list of new names of certain insect pests of crops, to the Entomologist, Government of Bihar; control measures against aphids on cabbage and peach leaves, to a correspondent from Kanda Ghat, Simla Hills ; control measures against red ants in flower gardens, to a correspondent from Manbhum District ; control measures against the rice stem borer, to a correspondent from Patiala State, PEPSU ; a note on remedial measures against white-ants and rodents damaging food grains in stores, to Messrs. India Copper Corporation, Ltd., Amla, Chota Nagpur ; a summary of investigations by the late Mr. H. M. Lefroy on thrips on tea at Phoobsering, Darjeeling, to a correspondent from Darjeeling ; information regarding the brown jassid, *Erythroneura subrufa* Matsch, a minor pest of paddy in the Kistna and Malabar districts to Mr. Herbert H Ross, Urbana, U. S.A., a note regarding observations on insect attack on bottle palm trees in Nicholson's Garden, Delhi, to the Superintendent, Horticultural Operations, New Delhi.

Over 114 packets and samples of seeds meant for export were suitably treated and the necessary certificates of health issued. Besides, 28 certificates on freedom from *Phylloxera* were issued to Messrs. G. Ghosh and Co., Town End, Darjeeling, in connection with the export of orchids to the U. S. A., Brazil and other countries.

A total of 423 coloured plates of insect pests of agricultural crops was supplied to various institutions and individuals. Those who received these plates included the agricultural Adviser to the Government of U. S. A. in India, Balwant Rajput College, Agra, Directorate of Plant Protection, Quarantine and Storage, New Delhi, the District Inspector of Schools, Hoshiarpur, East Punjab, Manager, Government of India Press, New Delhi, Entomologist, Agriculture and Food Department, Jaipur, (Rajasthan), Secretary, Indian Council of Agricultural Research, Government College, Hoshiarpur, (East Punjab).

The Division of Mycology and Plant Pathology attended to several enquiries received from all over India and abroad. Identifications of pathogenic and taxonomic specimens and fungal cultures were made for research workers from the various States and Universities in India. Information on references to literature on many topics and on the distribution of various fungi was supplied to several investigators. In addition, a number of scientific notes were written in connection with the enquiries received. About 350 samples of seeds and diseased plants were examined and suitable control measures suggested. The seeds were suitably treated and certificates of health issued wherever required.

(iv) Research Schemes

Work on the following schemes, financed by the Indian Council of Agricultural Research (I. C. A. R.), the Indian Central Sugarcane Committee, (I. C. S. C.), the Indian Central Oilseed Committee, (I. C. O. C.), was in progress in the different Divisions of the Institute during the year under report.

No.	Title of the scheme	Sponsored by	Division in which work was in progress
1	Kudzu Vine Scheme	I. C. A. R. ..	Agronomy and Botany.
2	Co-ordinated Wheat Rust Control Scheme	Do. ..	Botany and Mycology.
3	Scheme for the Improvement of Maize crop in India	Do. ..	Botany.
4	Scheme for the establishment of a Nucleus Organisation for the Introduction of New Economic Plants in India.	Do.	Botany.
5	Scheme for Research on Minor or Trace elements ..	Do. ..	Chemistry and Agronomy.
6	Scheme for Research on Nitrogen Fixation in Soil	Do. ..	Chemistry.
7	Scheme for the preparation of a Monograph on phosphate manuring in India.	Do. ..	Chemistry.
8	Scheme for tests with DDT, 666 and Allied insecticides ..	Do. ..	Chemistry, and Entomology.
9	School of Research in Entomology	Do. ..	Do.
10	School of Research in Mycology	Do. ..	Mycology.
11	Scheme on the diseases of sugarcane	I. C. S. C. ..	Mycology.
12	Linseed Rust Scheme	I. C. O. C. ..	Mycology.

(v) Collections and Herberia—

Living Plant Collections.—The Institute maintains collections of different species and varieties of crop plants such as wheat, barley, linseed, chilli, tomato, sweet potato, potato, various legumes, etc. These provide a wide range of variation in characters within a crop and is being used for breeding improved varieties. For purposes of exchange of materials and information with various plant breeding institutions of the world, this Institute has undertaken collaborative work with the Food and Agriculture Organization of the United Nations. From our extensive collection of the Indian wheats, 115 varieties have been selected for describing them for the ' World Catalogue of Genetic Stocks of Wheat ' being compiled by the F. A. O. Data on various agronomic characters, such as rust resistance, yield, etc., of these varieties are being collected.

Fungi and Micro-Organisms.—Sixty-four cultures of fungi were added during the year to the Indian Type Culture Collection maintained by the Division of Mycology, the total number of type cultures now maintained being 845. The Institute continues to be a member of the International Federation of Culture Collections and collaborates with the International Federation in promoting closer co-operation between the different culture collections of the world and in the preparation of a world catalogue of strains. Seventy-seven cultures were supplied during the year to various research workers, institutions and industrial concerns in the country and abroad. A list of the culture collections maintained at this Institute is now ready for circulation.

Insects.—The National Pusa collection of insects being maintained in the Division of Entomology contains a rich array of specimens. A number of interesting specimens, including 5 species of *Lepidoptera* and 21 of *Coleoptera*, has been added to the collection during the year under report. Many specimens were sent to different institutions and to individual experts both in India and abroad either for identification or for study.

Herbaria.—A small herbarium of economic plants has been started recently in the Division of Botany with the object of collecting economic plants and varieties of crop plants for their study and classification. A collection of common weeds of the crop fields is also being made. These collections are also helpful in the teaching of students as well as in the correct identification of plants. 1233 specimens of local plants were added to the herbarium during the year.

Eighty-eight specimens of Indian fungi were added during the year to the ' Herbarium Cryptoganie Indie Orientalis ' in the Division of Mycology. The total number of specimens in the Herbarium is now 19,881. It also contains 12 exsicati sets. Seventyfour specimens were supplied during the year under review to various research workers and institutions in India and abroad.

(vi) Plant Introduction—

Financed by the I. C. A. R., the small nucleus organisation for Plant Introduction at the Division of Botany has continued its activities on a wider field. The collection of indigenous and exotic plant materials has been maintained and further studied for assessing its value for economic utilisation either directly or through hybridization. 460 samples of seeds were received during the year taking the total collection to 3121 items. The following is a statement of seeds imported from foreign countries during the year 1950-51.

Name of the crop	No. of varieties obtained	Country from where the samples were obtained
Cereals including wheat, rice, oat, barley and maize ..	38	Holland, Italy, Australia, Burma and France.
Sorghum	4	Burma.
Pulses, including peas, cowpeas, soybean, ricebean ..	58	U. S. A., Brazil, Argentina, Rhodesia, Canada and Australia.
Oilseeds, including sunflower, castor, linseed and ground nut.	35	U. S. A., Argentina, Brazil, Columbia, Canada, Australia, S. Africa, Kenya, Sudan, Nigeria and Hungary.
Vegetables, root crops and species including potato, sweet potato, *Coleus*, tomato, beans, onion, etc.	216	U. S. A., U. K., Holland, Italy, Australia, Tasmania, Hawaii, Philippines and Burma.
Tobacco	4	U. S. A.
Grasses, including species of *Setaria, Axonopus, Brachiaria, Coix, Paspalum, Cenchrus*, etc.	30	Ceylon, E. Africa, Canada and Australia.
Legumes for fodder, forage and soil conservation, including Alfalfa, *Desmodium, Glycine, Centrosema, Calopogonium, Vicia, Crotalaria, Pueraria, Sesbania*, etc.	52	Ceylon, Cochin-China, Holland, Italy, Nigeria, Argentina and Canada.
Medicinal plants, *e.g., Urginea*	1	Sicily.
Wild relatives of cultivated plants, including wheat, barley, oats, egg-plant, tomato, linseed and potato.	22	U. S. A., U. K .and Australia.

Samples of specimens of plant materials collected during plant collection tours as well as of those maintained by the Plant Introduction Unit in the Botany Division are also preserved in the herbarium.

(*vii*) *Intensive Cultivation Scheme*

The Honourable Shri K.M. Munshi, Minister of Food and Agriculture set up a committee consisting of the Director, Indian Agricultural Research Institute, New Delhi (Chairman), the Deputy Commissioner, Delhi, the Development Secretary to Chief Commissioner and a nominated member of the Chief Commissioner's Advisory Council to co-ordinate the programme of the Intensive Cultivation Scheme in an area of 19 villages selected by the Delhi Administration for agricultural improvement. The Land Development Commissioner , Delhi also served on the Committee but he has later been replaced by the Development Commissioner, Delhi. The Committee met twice during the year to review the work.

The programme was executed by the Institute and the various working parties, one from each of the Divisions, were entrusted to carry through the practical recommendations of the different Divisions. Co-ordination was effected by weekly meetings of the Directors and Heads of Divisions.

II. DEMONSTRATION AND PROPAGANDA

(*a*) *Agronomical.* Demonstrations on the use of ammonium sulphate in mixture with Farm Yard Manure in the ratio of 1 : 5 by weight were carried out in three villages, namely, Nilwal, Qamaruddin Nagar and Ranhaula. The cultivators in all cases were satisfied that the extra outturn amply compensated for the cost of manure. In the middle of August, one plot each of improved varieties of chillies, tomato, brinjal and sweet potatoes were transplanted in Nilwal. Except sweet potatoes all other vegetables were approved for their quantitative and outturn characters.

In the *rabi* season in all 202 demonstrations on various crops were carried out of which 13 were demonstrations on a new variety (Co. 647) of sugarcane and six on 216F. Punjab American medium staple cotton are still in progress. N.P. 760 gave 42·2 mds. outturn of wheat under well irrigation. Highest yield of N.P. 710 obtained was 34·3 mds. In 9 plots out of 16 demonstrations this variety outyielded the local.

Nineteen demonstration plots of oats N.P. 1 in 10 villages were arranged. Peas N.P. 29 type was particularly appreciated for its sweet taste and high outturn. Barley N.P. 13 and gram N.P. 58 were sown somewhat late in 19 and 38 demonstration plots respectively. In spite of it their performance was better than local types.

Improved *Hooka* type of tobacco varieties S.20 and N.P. 18 outyielded local and *Culcuttia* type by a margin of 6·7 and 5·5 maunds per acre of dry leaves.

Ammonium sulphate was applied to 10 plots of wheat in six villages at the rate of 100 lbs. per acre. The extra grain yield ranged from 1·5 maunds to 3·0 maunds per acre.

(*b*) *Botanical.* Seed selection methods for Bajra, Jowar and Guar crops were demonstrated to the cultivators. Nursery was raised for improved tobacco, tomato, chillies and brinjal. These seedlings were later on distributed to cultivators. Demonstrations in the roguing of fields for maintaining purity of wheat varieties were carried out in 15 villages.

(*c*) *Entomological.* Besides treating the standing crops with insecticides, the process of roguing out " dead hearts " against the attack of sugarcane borers was demonstrated to the cultivators in various villages. About 3,000 rat holes were treated with cyanogas in a cropped area of over 400 bighas.

(*d*) *Mycological.* The demonstrations in roguing of smutted plants in wheat, barley and oats were arranged in several villages. The method of controlling this disease by solar heat treatment of the seed was also demonstrated to the cultivators. Controlling soil borne fungi by seed treatment with Agrosan GN was demonstrated to cultivators in Multi-purpose Co-operative Society, Nangloi.

(*e*) *Engineering.* Threshing operation with a tractor driven disc was demonstrated in Nangloi, Qumaruddin Nagar and Tikri Kalan villages. Its practical value as time saving, labour saving and economical method of threshing were brought home to cultivators.

III. SURVEY OF AGRICULTURAL RESOURCES AND PRACTICES

(*a*) A comprehensive survey of agricultural resources was conducted as a preliminary to starting intensive agricultural improvement work in these villages.

(*b*) *Soil Survey* : Survey of soil types and land use were carried out in five villages. In these villages land classes are divisible into :—

1. Loamy soils of moderate fertility.
2. Sandy loam soils of fair fertility.
3. Sandy soils of low fertility.

IV. EXTENSION OF AGRICULTURAL IMPROVEMENTS

(*a*) *Seed distribution* : The seeds distributed to cultivators were as under :

Wheat-C. 518—335 maunds.

Barley-MC. 251—291 maunds.

Cane seed of varieties Co. 312, Co. 453 and Co. 647—3,500 maunds.

Oats-N.P. 1—7 maunds.

(*b*) *Fertilizer sales* : 144 cwts. of sulphate of ammonia were distributed for application to wheat crop.

(*c*) *Grading of seeds* : With the aid of grader, 400 maunds of wheat seed of the cultivators were graded. This is helpful in connection with the stand of the crop.

(*d*) *Seed treatment* : Four hundred and twenty-five maunds of wheat and two hundred and ninety maunds of barley seeds were treated with Agrosan GN before sowing in October-November.

(*e*) *Pamphlets* : A series of six pamphlets on description t control major pests like " Kutra ", Phadka, mustard aphid, painted buge, red pumpkin beetle and ustard saw fly were prepared.

Besides, a pamphlet to method of the control of bacterial disease of wheat was prepared for publication by United States of America—Information Service.

V. CROP COMPETITION

In accordance with the scheme of crop competition of the Ministry of Agriculture about 800 entires for *Kharif* and *rabi* crops had been entertained from nineteen villages. The field staff is advising the cultivators to adopt intensive methods of increasing crop yields in these plots. Special arrangements have been made to treat seeds, grade them and supply as much of town compost and ammonium sulphate as the cultivators may require for enhancing their production.

VI. CONCLUDING REMARKS

This is the first year's report of the working of Intensive Cultivation Scheme. For developing into a model village Qamaruddin Nagar has been selected. The results of wheat yields have indicated that large seed blocks be built in Nilauthi, Ranhaula and Shafipur with varieties N.P. 775, N.P. 760 and N.P. 710. There is a growing demand for planting orchards and increasing production of vegetables. Plant Protection Service is in growing demand. The year's efforts have resulted in gaining confidence of the cultivators. Farmers are now more eager than before to seek advice, and applications from other villages to join the area have been received. These are happy signs for the future agricultural development of the area.

VII. PROGRAMME OF WORK FOR 1951-52

I. *Agronomy*

(*a*) Demonstration of improved varieties of crops and large scale manuring with ammonium sulphate as also improved agricultural operations.

(*b*) Seed distribution, multiplication and supply of manures.

II. *Botany*

Seed germination tests, examination for varietal purity and roguing of seed plots.

(VIII) SUPPLY OF PEDIGREE SEEDS AND STOCKS

As in the previous years, the demand for N.P. seeds, especially of wheat, from the different States was quite heavy. Since larger areas could not be cultivated for seed multiplication purposes, the supply of seeds fell far short of the demand. The following quantities of pedigree N.P. seeds of different crops were supplied by the Institute.

Crop	Quantities of seeds distributed.
	(in Maunds)
Wheat	159½
Barley	22½
Oats	25½
Gram	14¼
Peas	24
Lentil	16
Maize	9
Hibiscus	1
Potato	20½
Chilli	4

In connection with the work of the Intensive Cultivation Scheme, taken up by this Institute in 19 villages around Delhi the following quantities of pedigree seeds were distributed to cultivators : wheat-C518, 335 Maunds ; barley-C521 291 Maunds ; Seed Cane-Co312 Co. 453, and Co. 647, 3,500 Maunds and Oats-N.P. 1, 7 maunds.

During the year under review 217 pedigree cattle from the Sahiwal and Tharparkar herds were sold to different indentors from the Agronomy Division and the Agricultural Substation, Karnal,

respectively. These indentors included the Director of Livestock and Animal Husbandry, U. P. Army Headquarters, Western Command, New Delhi; Director, Animal Husbandry, Bihar and Cattle Research Station, Jubbulpore.

The total sale proceeds from the above mentioned transactions amounted to Rs. 67,203. The details of the cattle sold are given below :—

Cattle	Sahiwal	Tharparkar
Cows	22	20
Bulls	..	1
Bull (young)	76	61
Heifers	19	18
	117	100=217

(ix) Post Graduate Training

The activity of the Institute regarding the training of students was pursued with vigour during the year under review. Out of 162 applicants, 64 students were selected and admitted for the two-year courses of post-graduate training in the different Divisions as follows : 25 in Agronomy ; 13 in Botany ; 9 in Chemistry ; 9 in Entomology and 8 in Mycology. Of these, two students did not join the training and another two students discontinued their training after joining the Institute. In addition, 45 students were promoted to the second year and were allotted research problems on various subjects to qualify themselves for the Associateship Diploma of the Institute. A list of this is submitted by 56 students, who successfully completed the two-year-course of training in September 1950, is presented in Appendix No. II.

Besides the above, 15 students underwent short courses of training in the different subjects. Ten other students were permitted to work in the different Divisions as Honorary Research Workers.

The number of students who received post-graduate training, those who successfully completed the course, the number of honorary and paid Research fellows and the number of short course students who worked in the different Divisions during the year have been presented in table below :

	Agronomy	Botany	Chemistry.	Entomology.	Mycology.	Total
No. of students admitted to the First Year course ..	25	13	9	9	8	64
No. of students in the second year of training ..	18	8	5	7	6	45
No. of students who obtained the Diploma during the year.	19	14	8	6	9	56
No. of Honorary Research Workers	2	2	4	2	.. ..	10
No. of short-course students	..	1	12	2	..	15
No. of Research Fellows	..	3	3	1	1	8

Besides the regular course of training mentioned above, two out of the three Punjab University students, working in the Division of Soil Science and Agricultural Chemistry, obtained the M.Sc. degree of that University. A research fellow working in the Division of Entomology also obtained the M.Sc., degree of the East Punjab University by submitting a thesis on the " Biology of *Tetrastichus pyrillae* Craw ". The short course of training given to 12 students in the Chemistry Division was done in two batches, one ending in July, 1950 and the other terminating in April, 1951.

Some of the senior members of the staff of the Institute delivered a course of lectures on their respective subjects to the Indian Administrative Service probationers at the IAS Training School, Metcalf House, Delhi during the current year. At the request of the Principal, Central College of Agriculture, a special lecture on the " Improvement of wheats by breeding " was delivered in the Division of Botany to the final year students of that college. As in the previous years, a short course of lectures on crop physiology was also arranged in the Botany Division for the first year post-graduate students of the Agronomy and Chemistry divisions.

(*x*) *Conferences attended by the Director and Members of the staff*

Dr. B.P. Pal, Director, attended a number of meetings and conferences during the year under review. These included the meetings of the sub-committee of the Planning Commission to consider the expected shortage of essential articles due to international crises ; the various meetings of the Indian Council of Agricultural Research, such as Botany Committee as Chairman, Advisory Board and the joint meeting of the Advisory Board and the Governing Body, Wheat Rust Control Committee, Board of Research, Ad hoc Committee for agronomic development of a rural area in the West Bengal, Viswa Bharati ; Publication and Editorial Board Committee and the Conference of Directors of Research of the Central Commodity Research Stations and the State Directors of Agriculture ; the 6th (special) meeting of the All India Council of Technical Education ; Advisory Committee to Co-ordinate Scientific Research work under the Ministry of Agriculture ; Delhi Intensive Cultivation Committee ; meetings of the Indian Central Sugarcane Committee and the meeting of the Chemical Division Council of the Indian Standards Institution. Besides, the Director acted as a member of the Selection Committee of the Royal Commissioners for the 1851 Exhibition Science Research Scholarship and the Selection Committee for the Government of India's General Scheme of Cultural Scholarships to foreign students in India (1951-52).

Agronomy Division : Dr. T. J. Mirchandani attended an inter-ministerial meeting to discuss the question of placing all forms of technical education under the direct supervision of the Ministry of Education. He also attended a conference to consider the establishment of a development and research centre at Jodhpur to undertake comprehensive research on the problems of semiarid areas in India.

Botany Division : Dr. N. Parthasarathy attended the Breeding -Expert-Committee of the Indian Central Oilseeds Committee and Dr. R.D. Asana attended the Medicinal Plants Committee of the I.C.A.R. Dr. P.N. Bhaduri attended the 7th International Botanical Congress held at Stockholm (Sweden) during July, 1950.

Chemistry Division : Dr. S.P. Raychaudhuri attended meetings of the Chemical Division Council and Heavy Chemicals Sectional Committee of the Indian Standards Institution and Soil Research Sub-Committee of the Indian Roads Congress. He also served as the Secretary of the Expert Committee on Fertilizers and Manures, Ministry of Food and Agriculture, and acted as a member of the Superphosphate Advisory Panel of the Government of India. Dr. N.B. Das attended the 7th meeting of the Inter-departmental Committee on Nutrition held by the Ministry of Health in November, 1950.

Agricultural Engineering Division : Mr. R.V. Ramiah attended the meetings of the Dry Northern (Wheat) Regional Committee of the Indian Council of Agricultural Research and the Groundnut Hand Decorticator Sub-committee and '*Ghani*' Selection Sub-committee of the Indian Central Oilseeds Committee.

Entomology Division : Dr. E.S. Narayanan attended the following meetings and conferences :— The International Anti-Locust Conference held in New Delhi in November 1950 ; Biennial Conference of Sugarcane Research Workers, *Ad-hoc* Entomological Sub-Committee of the Indian Central Sugarcane Committee ; Expert Locust Committee of the Government of India. Along with Dr. S. Pradhan, he also attended the meetings of the Entomologists and Mycologists to discuss methods of assessment of losses due to pests and diseases to agricultural crops in India.

Mycology Division : Dr. R.S. Vasudeva attended several meetings which included those of the Advisory Board and the Annual General Meeting and the Wheat Rust Control Committee meeting of the I.C.A.R. ; joint meeting of the Standing Scientific Development Committee of the Indian Central Sugarcane Committee and the meeting of the Inter-departmental Committee on Insecticides of the Government of India. Also attended the joint meeting of mycologists and entomologists to discuss methods of assessment of losses. The Director and the following officers of the Institute attended the 38th Session of the Indian Science Congress Association held in Bangalore during the first week of January, 1951 : Drs. E.S. Narayanan, S. P. Raychaudhuri, S.V. Desai, N. Parthasarathy, S. Pradhan, N.D. Vyas, K.V.S. Satyanarayana and R. Prasada.

(*xi*) *Visitors*

During the year under review many distinguished persons visited the Institute. These included:— The Hon'ble Shri Rajendra Prasad, President, Republic of India. The Hon'ble Shri K.M. Munshi, Minister for Food & Agriculture. Shri Harekrushna Mahtab, the Hon'ble Minister for Industry & Supply.

The Hon'ble Shri R.R. Diwakar, Minister of State, Ministry of Information and Broadcasting.

Dr. A.A. Dowell, Professor of Agricultural Economics, University of Minnesota, Minnesota, U.S.A.

Shri G.L. Mehta, Member, Planning Commission.

Shri A.C. Guha, Member of the Parliament and Whip of the Congress Parliament.

Shri V.V. Sohoni, Director General of Observatories, New Delhi.

Loyd V. Steere, Counsellor, American Embassy.

Mr. I.C. Gray, Deputy Director, Military Lands Cantonments, New Delhi.

The Minister for Agriculture, Madhya Bharat.

Vice Chancellor, Annamalai University.

Iranian Delegates, Locust Conference.

U.S.S.R. Members of Soviet Delegation.

Dr. Hung-Chang Yin, Ph. D., Field Scientific Officer, UNESCO.

His Highness the Maharaja of Patiala.

Professor P.M.S. Blackett, Manchester University, England.

Prof. C.Y. Wu, Institute of Systematic Botany, Academia Sinica, Peking, China.

Shri S.C. Bhattacharya, Horticultural Development Officer, Assam, Gauhati.

Shri K.N. Kaul, Government Agricultural Institute, Kanpur.

Shri B.M. Pugh, Agricultural Institute, Allahabad.

Prof. A.D. Ross, University of Wiston, Australia.

Mr. Hendris of Parry and Co., Madras.

Prof. Jones, Leeds University, England.

Mr. Homi Talyarkhan, Journalist.

Prof. E.B. Ford, Oxford, England.

Shri R.S. Roy, Horticulturist to the Government of Bihar, Sabour.

Shri S.K. Sangal, Representative, United Press of India, New Delhi.

Shri B.V. Narayansawamy, Member, Indian Tariff Board, Bombay.

Prof. G.C. Howlett, National Research Council of Canada.

Dr. J.K. Dubey, Director of Agriculture, Bhopal.

Mr. Anders, Secretary General of the World Federation for the United Nations.

Mr. R. Suwardi, Officer of the Ministry of Agriculture, Indonesian Republic.

Mr. A. Sujenj, Officer of the Ministry of Agriculture, Republic of Indonesia.

Prof. S. Harland, University of Manchester, Manchester, England.

Prof. A. Muntzing, University of Lund, Lund (Sweden).

Dr. Edgar Anderson, Missouri Botanic Gardens, St. Lovis, Mo., U.S.A.

Mr. A.J. Millington, Institute of Agriculture, University of W. Australia, Australia.

PART II

REPORTS OF THE HEADS OF DIVISIONS FOR 1950-51

REPORT OF THE DIVISION OF AGRONOMY (INCLUDING AGRICULTURAL SUB-STATION, KARNAL) FOR THE YEAR 1950-51.

(DR. T. J. MIRCHANDANI)

During the year under report the research activities of the Division at Delhi were under the following heads : Weather and its effect on crops, manurial experiments with nitrogenous, phosphatic and potash fertilizers and their combinations and micro-nutrient elements, cultural and cultural-cum-manurial experiments, rotational, mixed-cropping and cultivator's holdings, varietal-cum-manurial and varietal trials, agrostology, irrigation, maximised production, cattle breeding and management and collaborative experiments with the states.

Weather and its effect on crops .—The Division of Soil Science and Agricultural Chemistry has now been given the charge of the observatory but for obvious reasons the record of meteorological observations is summarised below :

Month.	Mean Max.	Temperature (°F) Dep. from normal	Min.	Dep. from normal	Relative Humidity % at 7 A.M.	Rain fall in in.	Dep. from normal.	Mean wind velo. miles per hr.	Mean hrs. bright sunshine	Mean evaporation in inches per day
July 1950	92·0	—2·3	80.3	0·1	85·4	11·80	+4·16	4·22	6·15	0·2741
August 1950	91·0	—0·1	78·0	0·0	89·9	7·47	+2·49	3·08	6·66	0·2140
September 1950 ..	89·3	—3·4	75·0	0·7	89·6	5·98	—3·4	3·3	7·26	0·1853
October 1950 ..	89·7	—2·0	60·1	—3·6	78·2	0·00	—0·39	1·61	9·91	0·2148
November 1950 ..	80·2	—3·7	47·2	—3·5	43·9	0·00	..	2·26	9·91	0·1800
December 1950 ..	69·9	—3·4	39·2	—4·3	71·5	0·00	—0·16	2·29	8·77	0·1185
January 1951 ..	67·3	—1·9	43·3	—0·1	82·0	0·69	—0·26	1·93	7·56	0·0994
February 1951 ..	73·2	—1·5	43·4	—3·8	75·1	0·00	—0·85	3·19	9·48	0·1743
March 1951	82·2	—3·0	54·7	—1·3	75·0	2·02	+1·53	2·83	7·49	0·2107
April 1951	90·8	—6·7	63·2	—5·1	66·5	0·78	+0·52	3·63	9·83	0·3673
May 1951	101·6	—3·6	75·1	—2·9	42·0	0·02	—0·39	4·82	9·18	0·5361
June 1951	104·0	—0·3	81·2	—1·3	48·2	0·48	—1·26	5·22	8·61	0·5866

In July and August the rainfall was above normal. A heavy down pour of 7·42 inches on 21-7-50 damaged 37·2 acres under different crops due to water logging. In August also an area of 8 acres under *guar* and maize was similarly damaged. The winter was comparatively more cold and prolonged. This affected the germination of late sown crops and retarded the growth of crops in general particularly berseem in the initial stages. There were frosts on 2nd and 3rd of February which partially damaged the potato crop. In March a rainfall of 1·53 inches accompanied by heavy winds lodged most of

the *rabi* cereal crops. The damage was estimated at about 10-15%. During rest of the period t weather was good. Prevalence of good weather in May helped in the threshing of *rabi* crops.

Every rainy season crops suffer or fail completely in Shadipur A, Shadipur B and Mau: Blo (1-12) areas in the farm. At a cost of Rs. 937 8 0 four drains had been dug to command 280 acres the above area.

The average yield per acre of the farm for major crops during the year as also that of th previous year is shown below :

Crop	1949-50	1950-51
Wheat	20·4	18·
Oats	22·7	21·8
Barley	31·4	30·9
Peas	12·9	13·4
Gram	14·7	9·5
Berseem	583·0	533·9
Maize	12·26	13·9
Sugarcane	548·3	707·8

A comparative statement of costs in irrigation during the present year and the past two years given below.

Year.	Irrigation charges paid	Area irrigated.	Irrigation cost/acre.
1948-49	Rs. 87339	1774 acres	Rs. 49·3
1949-50	Rs. 75730	1717 acres	Rs. 44·1
1950-51	Rs. 58756	1629 acres	Rs. 36·3

Manurial experiments.—Building up of soil fertility through organic manures and inorganic fertilizers with and without legumes in rotation.

This experiment was started in 1946-47 with the following rotations : Wheat-maize-wheat-maiz (series IV) and wheat-maize-peas-maize (Series V). The experiment is now in its third cycle. Manur ing is done to *rabi* crops only. The yields of maize and wheat in the two series are given below :

	Series IV Grain yield in md/ac		Series V Grain yield in M.ac	
	Maize (PF2)	Wheat (C 228)	Maize (PF2)	Wheat C 228
A. No. manure	4·68	3·36	9·98	11·01
B. $(NH_4)_2SO_4$ at 60 lbs. N acre + Super at 100 lbs. P_2O_5 acre + K_2SO_4 at 100 lbs. K_2O acre.	4·93	3·86	10·04	11·25
C. F. Y. M. at 60 lbs. N acre + Super at 100 lbs. P_2O_5 per acre + K_2SO_4 at 100 lbs. K_2O per acre.	4·99	4·22	10·29	11·50
D. Castor cake at 60 lbs. N acre + Super at 100 lbs. P_2O_5 per acre + K_2SO_4 at 100 lbs. K_2O per acre	6·39	5·41	10·40	11·65
'F' test	Not sig.	Sig.	Not sig.	Not sig.
C. D. at 5%	..	0·93	..	..

As in the previous cycle inclusion of a legume, peas in the rotation increased the yield over that where no legume was included. In the yield of wheat cake gave the highest yield. In the previous cycle $(NH_4)_2SO_4$ responded better than F.Y.M. or cake. Inspite of heavy manuring deterioration in the yield of both the crops in series IV has become appreciable. With the next maize crop both the series will be closed.

Green manuring experiment on wheat (*time of burying sunnhemp with and without fetilizers*): The object was to sudy the technique of green manuring. The results are as follows :

Time of burying sunnhemp/ fertilizer	Grain yield in mds./acre.				
	Sup. @ 80 lbs. P_2O_5/ acre	$(NH_4)_2SO_4$ @ 15 lb. N per acre	Sup + $(NH_4)_2$ SO_4 *	Control	Mean
A. Sunnhemp buried after 4 weeks ..	20·67	19·58	18·49	16·91	18·91
A. Sunnhemp buried after 6 weeks ..	17·39	17·51	18·24	16·54	17·42
C. Sunnhemp buried after 8 weeks	25·42	21·16	23·84	23·11	23·58
D. Sunnhemp buried after 10 weeks ..	20·07	16·30	18·49	15·57	17·63
Mean ..	20·89	18·67	19·76	18·03	..

Main plot significant at 1%, C.D. at 1% 4·71 sub-plot significant at 5% C.D. at 5% 1·89 (*at the above doses).

Sunnhemp buried after 8 weeks gave the highest yield. Super phosphate at 80 lbs. P_2O_5 per acre had the best effect.

Response curve of nitrogen with wheat : The object of the experiment was to find out the standard response curve of nitrogen. The plots received a basic dose of 60 lbs. P_2O_5 and 40 lbs. K_2O per acre. Increasing doses of nitrogen in intervals of 10 lbs. per acre were applied and the response observed. In the first year the yields due to treatments were not significant. In the present year 'F' test was significant but the response was not regular as was to be expected but came in jumps. In another experiment on wheat to study the response of F.Y. M. in increasing doses of 5 tons per acre the results were significant last year but not this year.

Effect of different forms of inorganic nitrogen on wheat :

Wheat N. P. 52 was grown and fertilizers were applied with the first irrigation after sowing. The results were as follows :

Treatments	Grain yield in mds. per acre.
A. No manure	16·84
B. $(NH_4)_2SO_4$ at 20 lbs. N per acre	20·52
C. $(NH_4)_4SO_4$ at 40 lbs. N per acre	22·50
D. NH_4NO_3 at 20 lbs. N per acre	21·54
E. „ 40 „	24·98
F. $NaNO_3$ at 20 lbs. N per acre	22·31
G. „ 40 „	24·80
H. Urea at 20 lbs. N per acre	19·80
I. „ 40 „	22·67
'F' test significant C.D. at 5%=2·34	

E G I C F D B H A

40 lbs. N per acre showed better performance. Nitrogen as sodium nitrate at the above dose is better than that as $(NH_4)_2 SO_4$. However last year $(NH_4)_2 SO_4$ gave the highest yield.

Manurial experiment on potato with nitrogen and phosphorus :—The object of this experiment was to find the optimum dose of nitrogen and phosphorus for the crop as also the best method of application of the fertilizer. The results obtained with the *Phulwa* crop are given below :

N_0=40 lbs. N per acre as $(NH_4)_2SO_4$	182·92	'F' test significant.
N_1=80 lbs. N per acre as $(NH_4)_2 SO_4$	208·20	
N_2=120 lbs. N per acre as $(NH_4)_2 SO_4$	228·20	C.D. @ 1/%=29·7
P_0=30 lbs. P_2O_5 per acre as superphosphate	206·7	'F' test not sig.
P_1=60 lbs. P_2O_5 per acre as superhosphate	202·3	
P_2=90 lbs. P_2O_5 per acre as superphosphate	210·9	
D_0=fetilizers applied broadcast	198·3	'F' test not significant.
D_1=fertilizers applied 1″ below tuber	201·8	
D_2=fertilizers applied 2½″ to the sides & 1″ below tuber	219·9	

Application of 120 lbs. N per acre yielded significantly higher than 40 lbs. N per acre. Last year this was significant over 80 *as*. N per acre also. In contrast to results obtained last year, placement of fertilizer 2½″ to the sides and 1″ below the tube was not significant over broad casting.

Plant composition as an index of fertilizer requirements.

The object is to connect internal plant composition with yield and to get standard values for nutrients—particularly micronutrients. The results of the maize crop are given below :

Treatment	Grain yld. in md/ac.	Treatment	Grain yld. in md/ac.	Treatment	Grain yield in mds./acre.
$N_0P_{80}K_0$	18·90	$N_{40}P_{80}K_0$	24·96	$N_{80}P_{80}K_0$	36·29
$N_0P_{40}K_0$	19·66	$N_{40}P_{40}K_0$	28·74	$N_{80}P_{40}K_0$	26·08
$N_0P_0K_0$	17·17	$N_{40}P_0K_0$	27·60	$N_{80}P_0K_0$	27·98
$N_0P_{80}K_{60}$	21·55	$N_{40}P_{80}K_{60}$	25·71	$N_{80}P_{80}K_{60}$	32·14
$N_0P_{40}K_{60}$	20·04	$N_{40}P_{40}K_{60}$	32·52	$N_{80}P_{40}K_{60}$	24·58
$N_0P_0K_{60}$	19·28	$N_{40}P_0K_{60}$	22·30	$N_{80}P_0K_{60}$	28·35

The effects due to nitrogen are significant at 1% while the remaining effects and interactions are not significant.

N_2	N_1	N_0
29·12	26·86	19·45

Ther esults are in complete conformity with those obtained last year.

A wheat crop (N. P. 710) was taken without any fertilizer on the same plots. In yield of grain the effect due to nitrogen is significant at 5% other effects and interactions are not significant. The mean yields in mds. per acre are :

N_2	N_1	N_0	
33·43	27·80	22·47	C. D. at 5%=6·88

Analysis of leaf samples of maize are not complee, % N has been estimated in 54 samples, % P_2O_5 in 46, % K_2O in 36 and % CaO in 36 samples only.

Effect of low doses of phosphates on berseem and building up of *soil fertility* : The experiment is in its second cycle which commenced in *rabi* 1948-49. In *kharif* a crop of unmanured cowpeas was taken. In *rabi* berseem was manured as usual and three cuts of fodder and seed were taken. The results are given below :—

Treatment to berseem	Yield in maunds per acre		
	Cowpeas fodder	Berseem fodder	Berseem seed
A. F.Y.M. @ 16 lbs. P_2O_5 per acre	108·75	75·52	1·79
B. „ 32 „ „	127·23	169·52	2·48
C. „ 64 „ „	125·09	247·75	3·41
D. Super phosphate at 16 lbs. P_2O_5 per acre	110·52	172·79	2·40
E. Sup. phos. @ 32 lbs. P_2O_5 per acre	111·46	271·64	3·17
F. Sup. phos. @ 64 lbs. P_2O_5 per acre	135·17	363·40	3·67
G. Super @ 8 lbs. P_2O_5+F. Y. M. at 8/lbs.	97·2	159·72	2·49
H. Super @ 8 lbs. P_2O_5+ F.Y.M. at 24 lbs.	114·91	217·97	3·15
I. Super @ 8 lbs. P_2O_5+F.Y.M. at 56 lbs.	147·58	356·12	3·93
J. Super @ 24 lbs. P_2O_5+F.Y.M. at 8 lbs.	120·05	300·39	3·43
K. Super @ 56 lbs. P_2O_5+F.Y.M. at 8 lbs.	122·38	387·86	3·74
L. No manure	85·23	21·38	0·39
M. Fallow in *rabi*	117·62	..	..
'F' test	Sig.	Sig.	Sig.
C.D. at 1%	39·76	81·10	0·99
C. D. at 5%	29·89	60·81	0·75

In cowpeas residue of 64 lbs. P_2O_5 per acre in the form of super alone or super mixed with F.Y.M. or F.Y.M. alone gave significantly higher yields. In berseem green fodder and seed, super alone or in combination with F.Y.M. at 64 lbs. P_2O_5, 32 lbs. P_2O_5 and 16 lbs. P_2O_5 per acre yielded significantly higher over control. This is in conformity with results obtained in the previous year. The gradual decrease in the yield of no manure plot with the years is interesting and requires investigation.

Building up of soil fertility by growing phosphate manured berseem with guar in rotation.— The cropping scheme is berseem-guar-berseem-guar-berseem guar-wheat-maize (fodder)—wheat. Guar

failed in all the seasons due to water logging. The results of the maize and wheat crop taken during they ear are as under :

Treatment to previous berseem crop	Maize fodder dry)	Wheat (N.P. 710)
A. No manure	102·20	7·36
B. Super at 50 lbs. P_2O_5 per acre	67·53	9·56
C. Super at 100 lbs. P_2O_5 per acre	57·78	8·73
D. Super at 50 lbs. P_2O_5 + 80 lbs. K_2O per acre	64·97	9·55
E. Super at 100 lbs. P_2O_5 + 80 lbs. K_2O per acre	58·04	9·67
'F' test	Not sig.	Sig.
C.D. at 5%	..	1·68

E D B C A

In the wheat crop significant increases due to residual effect of fertilizers applied to berseem are indicated. In the previous wheat crop (*rabi* 1949-50) no such residual effect was indicated.

Effect of manuring berseem with and without potash and residual effect on maize-wheat-jowar: The results of the jowar crop taken during the year are given below :

Sub-plot treatment	Main plot treatments. Jowar in mds. per acre. Ammophos $N_{60}P_{30}$	Ammophos $N_{120}P_{140}$	Superphosphate+ $(NH_4)_2SO_4$ $N_{60}P_{80}$	Superphosphate+ $(NH_4)_2SO_4$ $N_{120}P_{160}$	Superphos P_{80}	Superphos P_{160}	No manure	Mean
K_0	94·8	81·6	87·2	85·6	81·7	84·4	64·9	84·0
K_{40}	92·7	92·4	94·7	73·0	73·0	92·6	54·0	81·8
K_{80}	68·4	76·5	74·2	95·4	66·5	100·4	63·9	78·0
Average	85·3	86·2	85·3	84·4	73·3	92·5	60·9	..

'F' test was neither significant for main plot treatments nor for sub-plot treatments or for interactions. In results of the maize and wheat crop taken last year no residual effect was also observed. The third cycle berseem crop was taken. All phosphatic treatments gave significantly higher yields than control. Effect due to nitrogen was also evident.

Effect of different forms of phosphates on berseem.—The experiment was started in *rabi* 1948-49. In the first year differences between the treatments were not significant. In the second year differences were significant and ammophos proved to be the best. The results of the present crop are as follows :

Treatment	Yield of berseem fodder in mds. per acre. *
A. Basic superphosphate at 80 lbs. P_2O_5 per acre	201·4
B. Ammonium phosphate at 80 lbs. P_2O_5 per acre	472·9
C. Ammonium sulphate to supply as much N as in B	276·2
D. Rousseau at 80 lbs. P_2O_5 per acre	336·6
E. Trichi nodules	..
F. Bonemeal	264·6
G. Superphosphate (triple)	225·8
H. Rock phosphate	173·6
I. Bonemeal compost	230·9
J. Control (no manure)	250·7
K. Agrophosphate @ 80 lbs. P_2O_5 per acre	213·9
L. Silicophos at 80 lbs. P_2O_5 per acre	162·5
M. Magnesium ammonium phosphate at 80 lbs. P_2O_5 acre	174·2
'F' test	Significant
C.D. at 5%	115·73

This year also ammophosphate proved to be the best. The residual effect of different forms of phosphates have been studied by growing maize-berseem-maize without any more fertilizers. The results showed that phosphates did not have any residual effect. This corresponds with results reported last year.

Phosphatic manuring of berseem—effect of B and Mo singly and in combination :—This is the second year of the experiment. Five cuttings of berseem fodder were taken and then the crop was left for seed. The results showed that major elements (Phosphates and $(NH_4)_2SO_4$) treatments were significant only in the first and second cuttings while the micronutrients are significant in all the cuttings. In seed yield both major and micronutrients are significant. The consolidated fodder yield and the yield of seed are given below :

	Consolidated fodder yield in mds. per acre.						Seed yield in lbs. per acre.					
	Super @ 80 lb P_2O_5 per acre	Rock-phos at 80 lbs. P_2O_5 per acre	Ammo-phos at 80 lbs. P_2O_5 per acre	$(NH_4)_2SO_4$ to supply N as in ammo-phos	No. manure Control	Mean	Super at 80 lbs. P_2O_5 per acre	Rock-phos at 80 lbs. P_2O_5 per acre	Ammo-phos at 80 lbs. P_2O_5 per acre	$(NH_4)_2SO_4$ to supply N as in ammo-phos	No. manure Control	Mean
	M	N	O	P	Q		M	N	O	P	Q	
Boron @ 5 lb borax/acre.	1016	937	1091	938	899	976	264	232	297	210	141	229
Molybdenum @ 1 lb. Mo O_3/ac	1048	1013	118	962	915	1011	241	228	263	193	127	210
B+Mo at the above doses	945	914	1030	878	853	924	214	207	215	167	117	184
No micronutrient. (Control)	908	848	1007	857	834	891	192	166	176	135	100	154
Mean ..	979	928	1062	909	875		228	208	238	176	121	..

Major element treatment

'F' test significant. C.D. at 1%=82

at 5%=58

O M N P Q

Micronutrients significant at 1%

C.D. at 1%=28, 5%=25

Mo B B+Mo C

Major element treatment

Significant at 1%

C.D. at 1%=67

5%=47

O M N P Q

Micronutrients significant at 10%

C.D. at 1%=22

5%=17

B Mo B+Mo C

Last year also the results were more or less similar.

Cultural and Cultural cum manurial experiment :

Cultural cum manurial experiment on cane (ratoon crop) :

Results are as follows :

A. Mainplot treatment-preparatory tillage.

	Mean yield in mds. per acre.
C_0 Desi plough	409·9
C_1 Tractor plough upto 6 inches followed by twice discing and grubbing	361·5
C_2 Tractor plough upto 10″ followed by twice discing and twice grubbing	356·2
'F' test	Not significant.

Desi plough is just as good as tractor plough.

B. Subplot treatments.

1. Time of application of N (80 lbs. per acre)	
T_0—Full dose at planting	371·8
T_1—Half dose at planting and half at earthing up	379·9
'F' test	Not significant.
2. Placement of phosphate	
D_0—Broadcast at planting	366·3
D_1—Placed in furrows before planting	385·4
'F' test	Not significant.

Last year also the conclusions were the same.

Cultivation cum manurial experiment in-rotation of maize-berseem-fallow-wheat : The object is to study the effect of depth of cultivation with and without inversion on the yield of crops in the rotation. The following table gives the results obtained during the year with a light soil.

Main plot.	Yield of maize grain md/acre.					Yield of wheat in mds./acre				
	No manure.	F.Y.M. @ 40 lbs. N per acre	F.Y.M. at 80 lbs. N per acre	F.Y.M. at 120 lbs. N per acre	Mean	No manure	F.Y.M. @ 40 lbs. N per acre	F.Y.M. at 80 lbs. N per acre	F.Y.M. at 120 lbs. N per acre	Mean
C_1 Tractor ploughing 9″ followed by tractor disc. ..	20·66	24·25	23·90	24·49	23·33	34·44	38·44	37·14	39·74	37·44
C_2 Bullock victory plough 5″ followed by desi plough ..	15·90	19·73	17·06	23·44	19·03	36·49	40·88	38·81	44·93	40·18
C_3 Desi Plough ..	15·90	19·73	17·06	23·44	19·03	36·49	40·88	38·81	44·93	40·18
C_4 Tractor disc ..	20·19	20·66	19·50	24·37	21·17	35·28	37·88	38·06	37·41	37·16
Mean	17·93	20·37	19·70	23·12	..	35·64	39·23	39·02	40·90	..

Main plot treatments not significant
Sub-plot treatments sig. at 1%
C.D. at 1%=3·60 mds.
N_3 $\overline{N_1\ N_2\ N_0}$

Mainplot treatments not sig.
Sub-plot treatments sig. at 1%
C.D. at 1%=2·34 mds.
$\overline{N_3\ N_1\ N_2}$ N_0

Last year also the conclusions were the same.

Manurial cum cultural experiment on maize (spacings, placements and manures). The object was to study the effect of various doses of fertilizers with and without basal dressing placement of fertilizers and distance between the rows on the yield of maize. The results are as follows :

	Treatment	Yield of grain in mds./acre.	
Basal dressing ..	B_0—no basal dreasing	22·73	'F' test not sig.
	B_1—F.Y.M. at 20 lbs. N/acre	23·68	
Nitrogen ..	N_0—20 lbs. N/acre as $(NH_4)_2SO_4$	17·73	'F' test sig. @ 5% @0·99.
	N_1—40 lbs. „ „ „	21·56	
	N_2—60 lbs. „ „ „	33·32	
Phosphate & potash	F_0—40 lbs. $P2O_5$+20 lbs. K_2O/acre	22·92	'F' test not sig
	F^1—80 „ „ „	23·49	
Spacing	S_0-24″ between rows	23·00	'F' test not sig
	S_1-30″ „ „	23·31	
	S_2-36″ „ „	20·30	
Placement	P_2—Broadcast at time of sowing	23·38	'F' test not sig
	P_1-in bands 4½″ on each side and 1″ below.	23·03	

Higher doses of nitrogen gave significantly higher yields, 60 lbs. N was superior to 40 lbs. N which in turn was significant over 20 lbs. N. Last year 24″ between rows had given significantly higher yield over 36″.

Mixed cropping :

Mixed cropping experiment kharif :—The object was to study the relative utility of mixed cropping *kharif* cereals (maize, jowar and bajra) with legumes, cowpeas in different proportions over individual cropping and to study the residual effect on the succeeding oats crop. The results are as follows :

Crop.	Treatment		Kharif 1950			Rabi 1950-51
	Ratio	Manure	Maize	Cowpeas	Jowar & cow-peas fodder	Yield in mds./acre, Oats (N.P.1)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Maize for grain		Unmanured	9·54	..	..	11·32
2. Jowar for fodder		„	..	..	241·25	9·41
3. Bajra for grain*		„	..	..	..	10·05
4. Maize for grain		10 ton FYM/ac.	11·32	..	..	12·98

(1)	(2)	(3)	(4)	(5)	(6)	(7)
5. Jowar for fodder		10 ton EXM/ac.	..	..	253·75	10·05
6. Bajra for grain*		....	..	..	..	11·06
7. Cowpeas for fodder ..			..	..	193·6	12·5
8. Cowpeas for grain			..	2·4	..	14·8
9. Maize + Cowpeas for grain ..	1·1		11·2	2·2	..	13·6
10. Maize + Cowpeas for grain ..	3·2		10·6	1·5	..	12·6
11. Maize + Cowpeas for grain ..	3·1		9·8	0·5	..	12·1
12. Jowar+Cowpeas for fodder	1·1		..	..	297·2	12·34
13. Jowar +Cowpeas for fodder	3·2		..	..	269·7	11·71
14. Jowar+Cowpeas for fodder ..	3·1		..	..	285·2	10·56
15. Bajra+Cowpeas for grain ..	1·1		..	1·79	..	12·85
16. Bajra+Cowpeas for grain ..	3·2		..	0·60	..	12·3
17. Bajra+Cowpeas for grain ..	3·1		..	0·51	..	11·1
18. Fallow during kharif ..			..	..	..	9·3
*Bajra failed to form seed.						
'F' test	Significant		Significant	Significant		Not significant
Conclusions : Maize	4 9	10	11	1		
Cowpeas ..	8 9	15	10	16	11	17
Jowar+"fodder ..	12 14	13	5 2		7	

In grain yield, maize manured with 10 tons FYM/acre and a mixture of maize with cowpeas (1:1) are superior to no manure maize or a mixture of maize and cowpeas (3:1); Cowpeas alone or a mixture of cowpeas and maize (1: 1) is superior to a mixture of cowpeas and maize (3 : 2) or bajra and cowpeas (1 : 1).

Varietal cum manurial and varietal trials.

Response of different varieties of wheat to nitrogen, sowing dates and time. The results obtained during the year are as follows :

	N.P. 165					N.P. 710					N.P. 771				
	a	b	c	d	e	a	b	c	d	e	a	b	c	d	e
Sowing dates	No	20 lb. N at sowing	20lb. N at 1st Irrigation.	40 lb. N at sowing	40 lb. N at first Irrigation										
20th Oct.	11·44	15·03	11·30	16·96	16·41	9·37	17·23	12·27	17·51	15·72	8·0	13·65	9·79	14·75	11·44
15th Nov.	9·37	17·65	12·27	19·16	13·65	11·72	17·23	12·68	21·09	18·61	11·44	15·85	11·58	18·61	15·16
10th Dec.	13·23	15·58	16·41	18·89	15·68	13·23	16·41	10·48	15·3	14·48	13·65	17·09	15·16	17·65	15·72

Effect of sowing dates and varieties are not significant. The effect due to nitrogen is significant at 5% C.D. at 5%=1·27.

d b e c a

Last year sowing dates, time of application of N was significant.

Varietal cum manurial trials on flax.—Three important rust resistant varieties were tried against N. P. 21. The results are given below :

Variety	Seed yield in mds. per acre. 20 lbs. N per acre. No.	20 lbs. N per acre.	Average
N. P. 21	8·7	10·5	9·6
B. 5128	6·2	9·1	7·7
Dakota flax	6·6	9·2	7·9
Sheyenne	5·4	6·9	6·2
Average	6·7	8·9	

'F' test Significant for varieties and treatments at 1%.
C.D. at 1 % for varieties=1·67
C.D. at 1% for varieties=1·18

N. P. 21 yielded significantly higher than other three varieties which showed no difference between themselves. Last year the results were not significant.

Varietal trial of tobacco.—This is the second year of the trial. The results obtained during the year are given below :

	NP 18	S13	S 14	S 19	S 20	S 22	Mean	F test
Mean yield of leaves	30·3	28·5	32·9	35·6	28·8	33·5	31·6	Not sig-
Mean yield of stalk	6·6	7·5	8·0	7·7	8·8	6·7	7·5	nifi-
Total yield of dry crops	36·9	36·0	40·9	43·3	37·6	40·2	39·1	cant
Leaf/Stalk	4·6	3·8	4·5	4·6	3·5	5·0		
% moisture in leaves	4·05	3·44	3·27	3·50	3·66	3·35		

Last year F test was significant S20 gave the highest yeild. This year S 19 has given the highest yield.

Varietal trial of linseed (flax) :—A trial to test several rust resistant varieties from the Botany Division showed that the differences amongst the varieties are not significant.

Variety	Yield in mds. per acre
Local	18·5
N. P. 21	21·1
RR. 10	20·5
RR. 191	19·5
RR. 193	18·0
RR. 197	20·3
RR. 208	20·9
RR. 236	19·8

'F' test—not significant.

Last year also the results were not significant. Local variety and N. P. 21 were attacked by rust at the seed formation stage.

Varietal trial of sweet potato : The mean yield of tubers in mds. per acre is given below :

Varieties	B219	T.S.T. White	F.B. 4004	Triumph.
Mean yield	87·0	123·1	82·7	13·9
'F' test	significant	C.D. at 5%		20·19
	T.S.T.White	B219	FB2004 Triumph	

Last year B 219 was the highest yielder.

Sannhemp varietal trial : In a trial in which U. P. 5-1, U. P. 5-2, BO 32-1, Assam 5-1, D13, D20, Java and C12 differences in yields, stalk weights are not significant.

Varietal trial of maize hybrids :—Yield of maize grain is given below :

Variety	Grain yield in mds. /acre.
A. Pusa yellow No. 2	21·12
B. Canadian Hybrid 275	13·60
C. Canadian Hybrid 416	17·56
D. Canadian Hybrid 531	13·20
E. Canadian Hybrid 355	16·63
F. Australian Hybrid 104	29·83
G. Australian Hybrid 431	31·68
H. Australian Hybrid 761	30·23
I. Australian Hybrid 739	26·14

'F' test significant at 5%

C.D. at 5%=5·29

Conclusions G H F I A C E B D

Australian hybrids performed better.

In a trial on the *ratooning capabilities of different canes*, seven varieties planted in 1949-50 were ratooned. In yield Co. 453 gave the highest, next was Co. 537. Last year Co. 537 was the best yielder.

Agrostology, Collection of grasses, ley farming :

In legumes *Dolichos sp.*, Hubam clover, Bur clover, *vicia sativa* showed promise. Dolichos sp grew very vigorously and two plants covered an area of 1/60th acre with a thick mat. Hubam clover started growth in February and continued to remain green till end of June. It gave an yield of 428 mds. per acre from a test plot. Bur clover yielded about 300 mds. per acre, in three cuttings from a test plot. *Vicia sativa* yielded 323 mds. per acre. In grasses *Phalaris, canariensis* showed promise by giving an yield of 252·6 mds. fodder per acre. *Panicum antidotale* yielded 950 mds. per acre in a year. A Napier grass collection from Jodhpur planted in the sewage area yielded 1800 mds. of fodder per acre in four cuttings.

Ley farming experiment.—The results of maize and wheat yield in one year ley plots and in the continuous rotation are given below :

Treatment	Yield in maunds per acre.					
	Fodder yield		Maize grain		Wheat grain	
	Manured	Un-manured.	Manured	Un-manured	Manured	Un-manured
A. Dichanthium mixture	263·1	230·89	6·58	8·77	9·65	9·99
	252·45		7·68		9·81	
B. Cenchrus mixture	255·61	244·13	10·24	8·29	14·53	12·29
	252·82		9·29		13·41	
C. Rhodes mixture	334·60	300·30	6·58	7·80	9·38	10·24
	323·21		7·19		9·81	
D. Cereal rotation (control)			11·94	9·26	12·09	10·63
			10·60		11·36	

Subplot treatments Significant at 1%
C.D. at 1%=44·74
C A B

Subplot sig. at 1%
C.D. at 1% =3·38
B D C A

In maize, manured plots in the continuous cereal rotation gave highest yields and were significantly superior to the yields obtained under manured one year Dichanthium or Rhodes mixture plots. In *wheat* Cenchrus ley plots yielded significantly higher than the Dichanthium and Rhodes ley plots but not over continuous cereal rotations.

Seed mixtures.—The object was to see the effect of legume association on the % protein of oats and Phalaris minor. The results are as under :

% protein

Main-plot treatments	Oats				Phalaris minor.			
	Grass 3/4+ 1/4 legume	Grass 2/3+ 1/3 legume	Grass 3/5+ 2/5 legume	Average	Grass 3/4+ 1/4 legume	Grass 2/3+ 1/3 legume	Grass 3/5+ 2/5 legume	Average
1. Oats/P. minor alone ..				10·33				9·16
2. With senji ..	11·27	11·63	12·17	11·69	10·55	11·55	11·56	11·22
3. With vicia	11·63	12·71	12·59	12·31	10·58	12·33	12·22	11·71
4. With peas ..	11·23	12·57	12·57	12·12	10·04	11·46	11·91	11·14

Mainplot treatment significant
C. D. at 5%=1·064
Subplot treatment significant
C.D. at 1%=0·885

Mainplot sig. at 5%
C.D. at 5%=0·867
Subplot sig. at1%
C.D. at 1%=1·297

Association of all the legumes showed significant increase in the protein % of both the grasses.

Kudzu vine : The flowering was normal and 265 pods were collected during the year. Propagation by means of crowns has been very successful and easier to handle, a 60-70% success has been reported from the States to which they had been sent.

I.C.A.R. Scheme :—There has been no response to the agronomic treatments given to induce early flowering.

Maximised production.—Attempts to get the maximum yield of the following crops under Delhi conditions gave the following :

Crop	Area	Yield in mds. acre.
Sugarcane	0·80	1100
Tobacco	0·75	38·1
Maize	2·5	19·7
Wheat	0·2	42·5
Oats	1·0	36·0
Jowar	1·0	14·0
Bajra	0·5	11·5

Cattle breeding and management.

1. The strength of the herd on the 30th June, 1951 was 76 head as against 367 head at the close of the last year. The herd consisted of 36 cows, 1 stud bull, 22 young male stock, 7 young female stock, 7 bull calves and 3 cow calves. The reduction in the strength of the herd was due to the transfer of 229 head of cattle in the month of May, 1951 to the newly started cattle-cum Dairy Farm at Karnal. The normal strength of the herd now fixed is 42 head comprising of 20 cows, 2 stud bulls, 10 young male stock and 10 young female stock. The animals in general maintained good health. Foot and Mouth disease appeared in the herd in May, 1951 and was responsible for the death of stud bull Balwan No. 27.

2. *Milk yield.*—The wet and overall average as recorded during the year under report were 19·7 lb. and 11·9 lb. per cow per day respectively, as against 18·4 and 11·7 lbs. recorded last year, which shows a slight improvement of yield over the last year. The herd had attained a peak yield of 1867 lbs. with 82 cows in milk one day in October, 1950. The wet averages for heifers, second calvers and adult cows were 17·6, 20·3 and 20·2 lbs. per day respectively. Out of 64 cows and heifers which completed their lactations during the year under report, 2 did over 9,000 lbs., 10 over 8,000 lbs., 14 over 6,000 lbs. of milk in a lactation period of 306 days. Eight heifers gave more than 6,000 lbs. of milk per lactation, the highest yield being 7,492 lbs. in 306 days, given by Syalmali No. 175. Among cows, twelve gave more than 8,000 lbs. milk yield in 306 days, the highest yield of 9,663 lbs. was given by Panarbila No. 81 in her third lactation.

3. *Calf rearing.*—Fiftyfour male and 39 female calves were born during the year. The average live-weights at birth were 49·8 lbs. and 47·5 lbs. respectively. There were ten deaths among the pailfed calves. The high mortality among calves was due to the appearance of calf-pyosepticalmia which has since been checked by injecting the calf with mother's blood serum after its birth. This gives the calf necessary protection against infection of the disease. Six calves died of pyosepticalmia. The mortality among pailfed calves was 10·8 per cent.

The growth rates of pailfed calves were as follows :

Male calves (up to 6 months)—0·9 lbs. per day.

Female calves (up to 8 months)—1·2 lbs. per day.

4. *Early maturity experiment.*—Nineteen early maturity heifers completed their lactations during the year under report. The average age at calving was 2 years, 7 months and 17 days and they yielded 5,310 lbs. milk per lactation of 306 days. The performance of early maturity, second and three calvers were as follows :

	No.	Age at 1st calving Y. M. D.	Yield (lb.) I	II	III
Second calvers	14	2-6-19	6077	6543	..
Third calvers	8	2-5-24	6586	7688	7723

It will be seen from the above that the milk yield of early maturity cows were not lowered as compared with the average yield of cows in the respective lactations.

5. *Four times milking and pre-milking.*—All cows were milked four times a day, except those which were weak and sick. In the latter case, the cows were milked two times a day.

All cows and heifers were handled and milked before calving. This treatment brings the cow into heavy flush soon after calving.

6. *Sale of cattle.*—Twenty two cows, 76 young bulls and 19 heifers were sold during the year under report.

Farm economies :

The cost of production of milk for the year 1949-50 worked out -/5/2 pies per lb. of milk. Data have been worked out on the cost of production of the main farm crops, input of human and animal labour, tractor power and water required for cultivation during 1948-49.

Cost of production of milk during 1949-50 (*A summary statment*)

	Rs.	A.	P.
1. Total cost of homegrown fodder (non-grain)	57702	12	0
2. Total cost of homegrown grain etc.	27428	0	0
3. Total cost of purchased grain concentrates	36688	13	0
4. Total cost of milk fed to calves	33501	0	0
5. Total cost of for office staff	27780	0	0
6. Total cost of gowalas	34443	12	0
7. Total cost of water and electricity	2262	12	0
8. Charge for building depreciation	5900	0	0
9. Charge for dairy land	900	0	0
10. Cost for bullock labour	6022	0	0
11. Cost for medicine	1100	0	0
12. Deadstock depreciation charge	630	0	0
13. Miscellaneous charges	8285	0	0
14. Initial Livestock valuation	27860	0	0
Gross Total Cost ..	270504	1	0
15. Closing livestock valuation	38250	0	0
16. Cattle sale proceeds	30901	0	0
17. Manurial value of residues	5000	0	0
Total value of output (except milk) ..	74151	0	0
Net total cost	196353	1	0
Gross total milk yield	619739	lbs.	
Total spoilages and shortages	1976	,,	
Net total milk yield	617763	,,	
Average cost per lb. of milk	0	5	2 per lb.

(Please see Appendix for Units of input of Human labour etc.).

I. Intensive Cultivation Scheme.

The work of Intensive Cultivation Scheme in the nineteen villages began on 2nd August. For efficient service the area was divided into two blocks of nine and ten villages, each under the charge of one field assistant. The Head Quarters of the Field Assistants were located at Nangloi Jattan which is centrally situated in the area.

II.—Survey of agricultural resources and practices.

The total area covered by these villages is about 1,05,100 bighas of which 81,100 bighas is cultivated. The area irrigated by Western Jamna Canal is 11,500 bighas and by percolation wells 14,900 bighas. This forms 32% of the cultivated area. The area grown on rainfall is about 54,700 bighas. Common grazing land and waste area constitutes 8,200 bighas. An area of 3,200 bighas is rendered uncultivable due to water stagnation in *kharif* but is brought under *rabi* vegetables, cereals and pulses. Predominantly the crops grown are cereals, gram and market crops, chillies, tobacco, vegetables and fodder crops. Amongst the cereals wheat and barley in *rabi* and bajra in *kharif* occupy major portion of the cereals area. Fodder crops grown are jowar for *kadbi* and green fodder in the *kharif* season and *Methra* and oats in the *rabi* season. The commercial crops are mostly grown under well irrigation.

The bane of agricultural Industy in the tract is the subdivision of holdings coupled with short season tenancies. Farmers are eager to consolidate their holdings.

Agronomic information of seed rates of crops, systems of cropping and rotations, manuring practices, size of holdings, number of ploughs per holding and per family were garnered for future work.

III.—Demonstration and Propaganda.

In the *kharif* season the work was begun rather late when most of the *kharif* crops had been sown, demonstrations were, therefore, arranged, with ammonium sulphate applied to chillies crops in five plots, to sugarcane in 2 plots, to jowar, radish and carrot in one plot, each. The plot size was about one bigha in each case. The nitrogen doses had been top-dressed at the rate of 20 lbs. N per acre. The cultivators in every case were satisfied that the extra outturn amply compensated for the cost of manure top dressed.

In middle of August one plot each of improved varieties of chillies, tomato and brinjal were planted in Nilwal. The chillies gave heavy bearing but early frost killed the plants before fruits could ripe. The variety preferred by the cultivator was N. P. 46. Tomato hybrid No. 4 set fruits in profusion and the cultivator continued to take crop till early January. The fruits were approved for their flavour and sweetness. Pusa purple variety of brinjals gave heavy bearing.

In the *rabi* season 202 demonstrations were arranged on improved varieties of wheat, barley, oats, gram, peas, berseem, tobacco, sugarcane and cotton.

Wheat variety N.P. 710 showed better performance under *barani* conditions and on highly sandy loam irrigated fields. Highest yield of N.P. 710 obtained in one plot was 34·3 mds. N.P. 760 performed superior under well irrigation on heavier loam. It gave 42·2 mds. yield per acre in one of the demonstration plots. Peas N.P. 29 type was particularly appreciated for its sweet taste and high outturn.

Improved *Hooka* type of tobacco varieties S. 20 and N.P. 18 out yielded local and Culcutta types by a margin of 6·7 and 2·5 mds. per acre of dry leaves. The size of leaf developed was over 15" in expanse.

Ammonium sulphate was applied to 10 plots of wheat in six villages at the rate of 100 lbs. per acre. The extra yield obtained ranged from 2 to 3 mds. per acre. Mixed application of 5 parts of

Farm Yard Manure and 1 part of sulphate of ammonia makes it possible to distribute it evenly without bringing the fertilizer in direct contact with the young plants.

IV. *Extension of Agricultural Improvements.*

(*a*) *Seed distribution* : 335 mds. of wheat seed of variety C. 518 was distributed in the different villages. 291 mds. of improved variety of barley C. 521, 3,500 mds. of seed cane of varieties Co. 312, Co. 453, Co. 647 and 7 mds. of oats N.P. 1 were also distributed.

(*b*) *Grading of wheat seed* : With the help of grader 400 mds. of wheat seed were graded for the cultivators.

V. *Crop Competition.*

800 entries for *kharif* and *rabi* crops had been entertained from these nineteen villages.

This year effort was put in to gain confidence of the cultivators to impress upon them that the scheme is meant for their ultimate good. Improved practices are being recommended to increase their crop production. In some of the villages people are eager to seek out advice.

Collaborative experiments : Experiments with paddy on the effect of magnesium ammonium phosphate on acid soils conducted at Kanke (Ranche Bihar) and Burdwan (West Bengal) did not give any significant differences in yield over other fertilizers.

PERMANENT MANURIAL AND ROTATION EXPERIMENTS AT PUSA

1. *Old manurial experiment.*

The experiment was conducted according to programme. The following crops were grown :

Series A. Maize in kharif and Peas in Rabi.

Series B. Maize in kharif and Barley in Rabi.

The results are as follows :

Yield of grain per plot in lbs. (Plot size : 1/4 acre)

Treatment	A series			B series		
	Kharif		Rabi	Kharif		Rabi
	Maize	Peas	Barley	Maize	Barley	Wheat
1. No manure check plot No. 1	74·06	14·25	..	26·44	220·06	..
2. Farm yard manure at 4,000 lbs. per acre ..	150·13	69·56	..	158·25	207·50	..
3. Farm yard manure at 8,000 lbs. per acre ..	209·50	137·50	..	199·31	279·80	..
4. Farm yard manure at 4,000 lbs. per acre *plus* Rape cake (20 lbs. N per acre).	228·19	133·44	..	207·50	265·25	..
5. Rape cake (20 lbs. N/acre)	187·13	65·50	..	148·06	127·38	..
6. Sulphate of ammonia (40 lbs. N/acre) ..	80·13	28·50	..	41·06	45·19	..
7. Sulphate of potash (50 lbs. K_2O per acre) ..	72·00	39·06	..	49·25	49·25	..
8. Superphosphate (80 lbs. P_2O_5/acre) ..	104·56	107·00	..	26·43	82·19	..
9. Sulphate of potash and superphosphate as in 7 & 8.	144·00	82·19	..	75·06	32·66	..
10. Sulphate of potash, sulphate of ammonia, Superphosphate as in 6, 7 and 8.	166·38	148·06	..	85·25	86·25	..
11. Sulphate of ammonia and superphosphate as in 6 & 8.	115·13	141·56	..	30·50	131·44	..
12. Green manure with purely cereal rotation ..	..	..	117·19	..	..	65·50
13. No manure check plot No. 2	43·13	32·56	..	8·13	53·31	..
14. Sulphate of ammonia and sulphate of potash as in 6 and 7	51·25	28·50	..	20·38	67·56	..
15. Green manure and leguminous crop in rotation	65·50	49·25	..	..	135·50	..
16. As in plot 15 plus superphosphate @ 80 lbs. P_2O_5 per acre.	166·38	90·31	..	..	257·06	..
17. No leguminous crop and no green manure ..	32·56	..	57·38	4·06	..	32·56
18. No manure check plot No. 3	24·44	22·38	..	8·13	117·19	..

2. *New manurial experiment* : The results are as follows :

Mean yield in lbs. per acre

(Maize and Wheat)

Treatment per acre	Maize	Wheat
A. No manure (Control)	178·10	253·7
B. Farm yard manure at 8,000 lbs.	426·54	356·6
C. Rape Cake at 40 lbs. N	466·55	325·6
D. Ammonium sulphate at 40 lbs. N	485·91	463·3
E. Potash sulphate at 50 lbs. K_2O	238·12	291·8
F. Superphosphate at 80 lbs. P_2O_5	218·11	285·8
G. Potash sulphate at 50 lbs. K_2O and superphosphate at 80 lbs. P_2O_5	231·66	225·4
H. Ammonium sulphate at 40 lbs. N, superphosphate at 80 lbs. P_2O_5 and Potash sulphate at 50 lbs. K_2O.	352·98	396·4
I. Ammonium sulphate at 40 lbs. N and superphosphate at 80 lbs. P_2O_5	380·73	540·6
J. Ammonium sulphate at 40 lbs. N and Potash sulphate at 50 lbs K_2O	395·57	417·0

		Maize	Wheat
'F' test		Significant at 5%	Significant at 5%
C.D. at 5%		133·58	101·1
for maize	D C B J I H E G F		
for wheat	I D J H B C E F A		

APPENDIX

Units of input of Human and Animal Labour, Tractor Power and Water (For Crop Cultivation During 1948-49)

Nature of input	Wheat	Berseem	Oats	Peas	Gram	Barley	Sugar-cane	Jowar	Maize	Maize & cowpeas	Cow-peas
	82·945 acres	61·93 acres	74·96 acres	30·48 acres	16·25 acres	6·50 acres	7·24 acres	65·205 acres	62·285 acres	16·96 acres	13·26 acres
Total Human labour input (In adult unit).	4406·41	5913·50	3001·50	1141·75	681·41	212·25	1146·80	1388·00	2692·58	655·50	315·50
Total Animal Labour input (in working days for a pair).	510·00	225·50	416·25	185·90	91·00	26·75	197·50	258·00	427·75	107·00	32·00
Total area worked by tractor power in acres.	261·385	111·34	174·34	45·39	39·75	21·25	45·25	105·62	180·485	30·40	27·02
Total area irrigated once through crop season (in acres).	160·00	751·51	150·42 (Except for sewage area of 12·21 acres).	39·48	6·50	2·75	63·30	4·25	44·72	113·6	20·20
Average number of labourers required per acre.	53·10	93·40	40·00	37·43	41·93	32·66	158·40	21·30	32·70	38·60	23·79
Average number of tractor operation per acre.	3·15	1·80	2·32	1·50	2·45	3·27	6·25	1·62	2·19	1·80	2·04
Average number of pair of bullocks per acre.	6·15	3·64	5·55	6·03	5·60	4·11	27·23	3·96	5·20	6·31	2·41
Ave. No. of irrigations done per acre for the whole season.	1·93	12·13	2·39	1·30	0·4	0·42	8·87	0·06	0·54	6·7	1·5

M/N33IARI

Programme of Work for 1951-52.

1. *Soil fertility problems* :

(*a*) *Manurial experiments on cereals and crops in rotation.*

(*i*) *Nitrogenous manures and fertilizers* : Experiments to test the relative values of nitrogen inorganic and inorganic manures and also responses of their combinations on wheat, maize and paddy.

(*ii*) *Phosphatic fertilizers* : Experiments with the different forms of phosphatic fertilizers to study their responses on *kharif* and *rabi* legumes and after effects on cereals following the legume.

(*iii*) *Nitrogenous and phosphatic fertilizers* : To study the relative merits of different types of nitrogenous and phosphatic fertilizers at ten Experimental Stations all over India.

(*iv*) *Nitrogenous, phosphatic fertilizers* : Experiments to study the effect of these each at different levels and in combinations on the yield of wheat.

(*v*) *Green manures* : Experiments with different legumes as green manures with and without fertilizers on wheat. Experiments to study the effect of green manuring when the crop is grown *in situ* and brought from outside. Green manuring expt. with *guar* in conjunction with micronutrients.

(*vi*) *Manurial and cultural experiment on sugarcane.*

(*vii*) *Permanent Manurial and New Manurial experiments of Pusa.*

(*viii*) *Micro-nutrient studies.*

(*b*) *Placement of fertilizers in row crops* : To effect economy in the quantity of fertilizers used and their better utilization by field crops.

(*c*) *Mixed Cropping of Cereals and legumes* : To study the possibility of maintaining soil fertility by growing a mixture of cereals and legumes under different fertilizer treatments.

(*d*) *Mixed farming.* To obtain maximum overall yields wich a cultivator is likely to get from holdings of 6 acres under irrigated conditions designed to meet the requirements of his family members and cattle and produce milk for cash sale.

2. *Irrigation experiments* : (*i*) To study the influence of depth of furrows on irrigation of potatoes. (*ii*) To study the effect of spray irrigation.

3. *Cultural experiments* : Planting distance of potatoes, depth of sowing gram, different preparatory tillage treatments on sugarcane, spacing in maize and cotton, tillage experiments on wheat and maize, dates of sowing and intercultural experiment on maize.

4. *Varietal yield trials* : Experiments will be conducted with improved varieties of different crops such as S. cane , wheat, tobacco, potatoes, sweet potatoes, tomatoes, cotton, maize hybrids, chillies, pigeon pea, and linseed.

5. *Agrostology* : To produce high yielding and palatable fodder grasses and legumes for cattle, increase the productivity of natural grasslands ; to work out suitable seed mixtures of grasses and legumes for pasture, to evolve a suitable system of ley farming, maintenance of nursery.

Cattle Breeding and Management

1. Line breeding and selection for improvement of milk yield.
2. Handling of the stock for the development of milk temperament.
3. Feeding of stock on balanced rations for growth, early maturity and high milk production.
4. Four times milking as a means of stimulation for the production of high yield.
5. Pre-milking as a means of stimulation for milk production, to train heifers to milk before calving and to prevent udder trouble.
6. Calf rearing on standardised milk ration containing 3·5 percent. butter fat.
7. Early maturity treatments to test bulls for their transmitting capacity of high milk yield quality at an early age.

INDIAN AGRICULTURAL RESEARCH SUB-STATION, KARNAL FOR 1950-51

General :—

The total area of the Substation is 2,154 acres out of whch 285·50 acres remained with the Punjab Government and 51·42 acres with the Sugarcane Sub-Station. The areas cropped in the *kharif* and *rabi* seasons were 564·81 and 553·88 acres respectively. In addition to this, 107·77 and 301·46 acres were cultivated on share system (Batai) in the *Kharif* and *Rabi* seasons respectively. Due to the re-organisation of the farm on 1st April 1951, 180·12 acres were retained by the Indian Agricultural Research Sub-Station and 1,973·68 acres were transferred to the Cattle-Cum-Dairy Farm Karnal.

The main activities of the Sub-Station were (*i*) to carry out large scale field experiments on different aspects of agronomic research, (*ii*) multiply and distribute seeds of improved strains of field crops, (*iii*) improve the milch and drought qualities of the Tharparkar breed (dual purpose cattle) by line breeding and judicious managements and (*iv*) render assistance to the different Divisions of the Institute in carrying out their field experiments.

Out of three Tube-wells sanctioned by the Government of India for irrigation purposes, one was sunk in November 1948 in Block No. 5 the second was sunk in December 1950 in Block No. 3 and the third was sunk in January 1951 in Block No. 4. The tube-well of Block No. 5 is being worked from June 1951.

The position of tractors and tractor implements remained unsatisfactory.

Crop Section

Response of Crops to seasons :—

The total rainfall from 1st June 1950 to 31st May 1951 amounted to 35·29 inches as against 27·25 and 31·44 inches recorded during the corresponding periods of 1949-50 and 1948-49 respectively. The abnormally high and continuous rainfall of 14·57 inches in July, 1950 led to the late sowing of some of the *Kharif* crops except paddy and this lowered the yields of the former crops to some extent. High wind accompanied with rain in August 1950 damaged maize and Sugarcane severely and reduced their yields. Ground frost in December 1950 adversely affected the crop of cowpea for seed in as much as the entire crop dried up prematurely. The *rabi* season was favourable for the growth of all the crops. But due to rain and high wind in the last week of March, 1951 all the standing crops specially wheat, barley and oats lodged very badly. These climatic factors were responsible for slightly reducing the yields of these crops.

Top borer (chilo Sp.) did a lot of damage to maize. Cotton was attacked by crotogonus sp. and the damage caused was rather severe. Gram suffered due to wilt.

The yields of principal crops grown on the Farm are given below :—

Yields of Principal Crops Grown during the Year 1950-51

Crop	Retained by I.A.R.S.		Transferred to C.C D.F. Karnal.		Remarks
	Area (acres)	Average yield per acre (mds)	Area (acres)	Average yield per acre(mds.)	
(1)	(2)	(3)	(4)	(5)	(6)
GRAIN :—					
Paddy	65·73	24·37	..	..	
Maize	30·02	8·60	..	..	
Jowar	4·15	3·03	..	..	
Guar	24·11	10·07	..	..	
Cowpea	27·22	6·10	..	..	
Wheat	79·95	20·56	..	..	
Oats	2·65	19·25	46·97	18·74	
Barley	1·00	28·05	..	..	
Gram	4·75	17·99	62·50	14·29	
Mustard & Gram	..	..	69·47	12·66	
Pea	3·00	5·04	..	..	
Berseem	5·04	3·11*	10·00	3·02†	*840 mds. of green berseem was also taken. †900 mds. of green berseem was also taken.
FODDER :—					
Jowar green	67·80	225·07	..	..	
Cowpea green	13·77	205·37	..	..	
Guar green	1·50	254·67	..	..	
Jowar & Cowpea, Mixed green	56·15	204·06	..	..	
Maize & Cowpea, Mixed green	15·56	175·71	..	..	
Berseem green	31·20	636·15	27·53	286·66	
Oats and pea mixed green	9·14	252·41	..	..	

Research projects :—

Manurial experiments : *Effect of bonemeal, Farmyard manure and ammonium sulphate on paddy and their residual effects on berseem* : The results were not conclusive as the differences among the treatments were not significant.

Direct manuring of paddy with ammonium sulphate and indirect manuring with farmyard manure and bonemeal : The results did not show significant differences among the treatments.

Direct and indirect manuring of paddy and berseem : This elaborate experiment is to study the effect of N and P_2O_5, each at three levels and their combinations on berseem and paddy. The results were not significant in the case of paddy while those in the case of berseem indicated highly significant differences amongst the treatments. Berseem gave significantly superior yield when phosphate was applied either to the previous crop of paddy or directly to berseem. The treatments (1) 60 lbs., N plus 160 lbs. P_2O_4 and (2) 30 lbs.N plus 80 lbs P_2O_5 applied to berseem in general, have given higher yields over rest of the treatments which are 812·8 and 799·5 maunds per acre respectively.

Paddy nursery manurial experiment : The object of this experiment is to study the effect of manures and fertilizers when applied to the nursery and to see how far the vigour and extra growth induced by manuring in the nursery are reflected on the final yield of paddy without further treatment after transplanting. The treatments comprised of three forms of nitrogenous manures applied at four levels in combination with three levels of phosphatic fertilizer. The results did not indicate significant differences among the treatments or their interactions. The application of nitrogen at 200 lbs. per acre, however, gave the highest yield.

Green manuring of wheat in conjunction with fertilizers : In this experiment four green manuring crops *viz.* sunnhemp, cowpea, *moth*, and *guar* have been included. They were manured with 80 lbs. phosphate at the time of sowing while the subsequent crop of wheat C. 518 was manured with 40 lbs. N, 80 lbs. K_2O and 40 lbs N plus 80 lbs K_2O Sunnhemp and cowpea did not differ significantly from each other and were found significantly superior to *Guar* and control. Among the fertilizer treatments NP, N, NK, and NPK (P applied to the green manure crop) did not differ significantly among themselves but gave significantly better results than the other treatments. Like last year, it was found that phosphate alone applied to the green manure crop was not as effective as nitrogen applied to the wheat crop or nitrogen in conjunction with phosphate to the green manure crop or nitrogen with potash applied to the wheat crop or nitrogen and potash applied to the wheat crop in conjunction with phosphate to the green manure crop. The interaction between green manure and fertilizer treatments was not significant. The average yields of wheat due to various treatments are given below :—

Main plot treatment	Average yield per acre (Mds.)	Sub-plot treatment	Average yield per acre (Mds.)
Sunnhemp	24·65	NP	26·51
Cowpea	23·64	N	26·09
Moth	20·94	NK	25·54
Guar	19·87	NPK	25·30
No. Green Manure	19·11	P	17·76
S. Em	±1·18	PK	17·41
F-test	Highly significant.	No fertilizer	·38
		K	7·15
C. D. at 5%	3·63	S. Em	0·67
C. D. at 1%	5·09	F-test	Highly significant.
		C.D. at 5%	1·89
		C.D. at 1%	2·51

Green manuring with sunnhemp in conjunction with phosphate applied at different intervals : Th object of this experiment is to study the effect of green manuring in conjunction with superphospha at 80 lbs. P_2O_5 per acre applied at the time of sowing and burying sunnhemp and at the time of sowi wheat on the yield of wheat. The statistical analysis showed highly significant treatment difference

From the yields of wheat N. P. 4 obtained, it was found that the effect of phosphate applied to th green manuring crop at the time of burying (13·45 mds. per acre) was significantly superior to tha of phosphate applied to the green manuring crop at the time of sowing (11·67 mds. per acre) and n green manuring (8·50 mds. per acre). The yields of wheat due to the effect of phosphate applied the wheat crop after green manuring was 13·23 maunds per acre and that due to green manurin without phosphate was 11·71 maunds per acre.

Agrobiological studies on paddy : A new experiment on Agrobiological studies on paddy N.P. 1 was started during the year under report to determine the response to graded doses of nitrogen in d matter production of paddy. The levels of nitrogen varied from 22·5 lbs. to 202·5 lbs. per acre wi a dose of P_2O_5 and K_2O equivalent to 10 Baule units of each nutrient in the soil. The treatme differences were highly significant for gross dry matter yield, out-turn of grain and straw yield. Th yield of paddy was reduced with the increase in the dose of nitrogen due to lodging of crop. Th proportionate loss in paddy grain yield due to lodging was reciprocal to increase in the nitrogen dos The residual effect of the various treatments on berseem was not significant.

Chilli manurial experiment : This experiment was laid out in 1950-51. The fertilizer treatmen consisted of N, P. K, NP, NK, PK, & NPK. The yields of chillies did not show significant differenc between the treatments.

Varietal Trials

Sweet potato varietal trial : Six varieties of sweet potato were tested for their yield of tub The varieties indicated highly significant differences. Variety F. A. 17 white gave the highest yie (51·56 mds. per acre) and this was followed by B219, (17·79 mds. per acre) F. B. 4004 (17·79 mds. acre), Native white (13·79 mds. per acre), B 4306 (4·35 mds. per acre), and Jullundur I (2·90 mds. acre).

Wheat Varieal trial : Twelve N. P. wheat varieties of 700 series together with Punjab C. 518 a C. 591 were included in a trial to test their yields. The results were found to be highly significa Variety N. P. 710 gave the highest yield (34·87 mds. per acre) and this was followed by C. 518 (34· mds. per acre), N. P. 760 (34·36 mds. per acre) and N. P. 720 (34·32 maunds per acre). The differen among these varieties were not significant but they were significantly superior to varieties N. P. 7 (30·68 mds. per acre), N. P. 658 (29·27 mds. per acre). N. P. 761 (26·95 mds. per acre) and N. P. 7 (26·85 mds. per acre). The last three varieties did not differ significantly among themselves and yie ed the lowest.

F. A. O. Maize hybrid trial : 36 hybrids received from U. S. A. along with two local varieties we tested for their yield of grain. One of the hybrids *viz.*, Wisconsin 1,600 failed to form cobs. Th statistical analysis with the remaining 35 hybrids and two local varieties, showed highly significa differences between them. Dixie 11 gave the highest yield (18·55 mds. per acre) and this was follo by Ohio K. 35 (17·78 maunds per acre), Dixie 18 (17·35 maunds per acre), North Carolina (17· maunds per acre), Texas 18 (15·40 mds. per acre), U.S. hybrid 13 (14·89 mds. per acre), Indiana 2 B (14·63 mds. per acre), Ind 416B (14·55 mds. per acre), Iowa 4316 (14·38 mds. per acre) and Wiscon 595 (14·29 mds. per acre). These varieties did not differ significantly among themselves. Di II was significantly the best as compared to the remaining hybrids and the local varieties.

Australian and Canadian maize hybrids trial : Four Australian and five Canadian maize hybr together with two local varieties were included in a trial to test their yields of grain. The results w found to be highly significant. The Australian hybrids Q 431 (17·87 mds. per acre), Q. 739 (15·99 m

er acre), Q 716 (15·91 mds. per acre) and Q 104 (13·61 mds. per acre) did not differ significantly among nemselves, but Q 431 had significantly higher yield as compared to Local white (11·74 mds. per acre), ocal yellow (9·02 mds. per acre), and Canadian hybrids. Australian hybrids Q 739, Q 716 and . 104 did not differ significantly from local white. Local white was significantly superior to all the anadian hybrids. Local yellow did not differ significantly from Canadian hybrids, D. C. No. 416 ·10 mds. per acre) and D. C. No. 1531 (3·57 mds. per acre) but it was significantly better than D.C. o. 355 (3·40 mds. per acre), D. C. No. 275 (1·11 mds. per acre) and D. C. No. 150 (0·43 mds. per ere) Canadian hybrids did not differ significantly among themselves.

Commercial maize hybrids trial : In this trial seven commercial hybrids and two local varieties f maize were tested for their yield of grain. The results were significant. Hybrid U. 80 (15·14 mds. per ere) yielded the best. Hybrid U. 72 (11·06 mds. per acre), did not differ significantly from local ellow (10·45 mds. per acre) hybrids U. 65 (10·29 mds. per acre), U. 6 (10·29 mds. per acre), U. 59 10·12 mds. per acre), Local white (9·78 mds. per care) and hybrid U. 41 (9.27 mads. per acre) but it ffered significantly from hybrid U. 32 (7·49 mds. per acre). Local yellow, U. 65, U. 6, U. 59, Local hite, U. 41, and U. 32 did not differ significantly among themselves.

Cultural Experiments

Paddy cultivation experiment : The object of this experiment is to make a comparative study of the ffect of tractor ploughing and bullock ploughing given (*i*) after the harvest of paddy, and (*ii*) at ·mal time *i.e.*, before transplanting, on the yield of paddy N. P. 97. The treatment differences ere significant. Tractor ploughing at normal time (25·81 mds. pe acre) gave the best result. This reatment was followed by (*i*) bullock ploughing after the harvest of paddy (21·41 mds. per acre), *i*) bullock ploughing at normal time (20·38 mds. per acre), and (*iii*) tractor ploughing after the arvest of paddy (20·22 mds. per acre). The last three treatments did not differ significantly among hemselves.

Tillage of wheat in conjunction with manuring with farmyard manure and ammonium sulphate : eed bed preparations were made with (*i*). tractor plough (*ii*) bullock drawn inversion-cum-noninver- on plough and (*iii*) bullock drawn noninversion plough. The differences in the yield of wheat . P. 165 due to cultural treatments were not significant. The manurial treatments consisted of) ammonium sulphate 60 lbs. N, (*ii*) F. Y. M. 60 lbs. N. and (*iii*) ammonium sulphate plus F. Y. M. supply 30 lbs. N. each. The results showed highly significant differences between the manurial treat- ents. The treatments with ammonium sulphate plus F. Y. M. (16·62 maunds per acre) and ammo- um sulphate (16·47 maunds per acre) behaved alike and were significantly superior to the treatments ith ' F. Y. M. '. (13·37 maunds per acre) and ' no manure ' (10·34 maunds per acre). The treat- ent with ' F. Y. M. ' was also significantly better than ' no manure ' The interaction between the ultural operations and manurial treatments was not significant.

Tillage of wheat in conjunction with green manuring and application of fertilizers : The cultural eatments in this experiment were (*i*) tractor ploughing and (*ii*) bullock drawn inversion-cum-non- version ploughing. The whole area was green manured with sunnhemp in the *Kharif* season. The llowing fertilizer treatments were given—(*i*) 80 lbs. P_2O_5 at the time of sowing sunnhemp, (*ii*) 80 lbs. $_2O_5$ plus 120 lbs. K_2O at the time of sowing sunnhemp, (*iii*), 60 lbs. N to wheat, (*iv*) 60 lbs. N plus) lbs. P_2O_5 to wheat and (*v*) 60 lbs. N plus 80 lbs. P_2O_5 plus 120 lbs. K_2O to wheat. The yield of heat N. P. 165 due to tractor ploughing and bullock ploughing were 23·75 and 21·77 maunds per re respectively and the difference between the cultural treatments, was not significant. Among e fertilizers treatments, those applied to wheat *i.e.*, N, NP, and NPK were significant over those plied to the green manure crops *i.e.*, P. and PK. Their respective yields were 27·89 , 26·24, 26·02, ·69 and 17·78 maunds and that of control was 19·98 maunds per acre. It will be seen that these ults confirm those reported earlier under " green manuring of wheat in conjunction with fertilizers". e interaction between the cultural and manurial treatments was not significant.

Paddy Cultural Experiment : This experiment was laid out during the year under report. Two varieties of paddy (N. P. 97 and N. P. 137) were transplanted after berseem on three dates (1 July, 15th and 31st July) at three spacings (4″, 6″, and 8″) with one seedling per hole and two seedlings per hole, to study whether such treatments would influence the yield of paddy. The results did not indicate significant differences among treatments or their interactions.

Potato Cultural Experiments : An experiment with *Phulwa* variety of potato was started during this year. The treatments consisted of three dates of sowing (27th & 28th September, 12th & 13th October, and 28th & 29th October,) three spacings (1·5′, 2·0′ and 2·5′) and three times of applications of NPK fertilizers (full dose at sowing; half dose at sowing and half dose at first earthing up and one third dose at sowing, one third dose at first earthing up and one third dose at second earthing up). The yields did not show any significant effects or interactions.

Cultivators' Holdings.

Long term experiments with five, 6-acre cultivators' holdings were in progress to study how far they are self-sufficient in providing the requirements of five human beings and seven cattle. All these holdings were worked by bullock power. The yields of most of the crops in all the holdings were better than those in the previous year. No definite conclusions have yet been drawn from the experiments.

Seed supply :

The following quantities of seeds of improved varieties of crop were distributed during the year under report :—

Crop	Quantity (Maunds)
Paddy	11·63
Maize	1·00
Cowpea	0·55
Soyabean	0·13
Wheat	390·99
Oats	3·25
Barley	2·38
Gram	0·15
Pea	0·99
Berseem	0·45
Methra	0·20
Sugarcane	3,754·50
Total	4,166·22

Cattle Breeding Section

General :—

The strength of the herd on 31st March 1951 was 289 head comprising of 82 cows, 10 stud bulls, 62 young male stock, 103 young female stock, 13 male calves, and 19 female calves. This represents an increase of 20 percent. over the normal strength of 240 heads. The animals in general maintain good health. They were protected against Haemorrhagic Septicoemia by preventive inoculations. There was no out-break of contagious or infectious disease in the herd during the period. The total number of mortality in the herd was 18 consisting of one cow, one bull, seven young stock and nine sucklings.

Milk Yield :—

The wet and overall averages recorded during the period under report were 19·6 and 13·1 lbs. per cow per day respectively. 3 Cows did over 8,000 lbs., 5 cows over 7,000 lbs., 8 cows and 5 heifers over 6,000 lbs. of milk in a lactation period of 306 days.

Calf Rearing :—

23 male calves with an average birth weight of 48·8 lbs. and 28 female calves with an average birth weight of 46·4 lbs. were born. They were weaned at birth and reared by pail feeding. Their rate of growth is indicated below :—

Rate of growth in lbs. per day.

	Upto 3 month	3 to 6 months	6 to 8 months
Male	0·83	0·90	0·77
Female	0·84	1·00	0·95

The mortality was 17·7 percent. There were nine deaths and these were due to Enteritis in one Naval-ill in one, colic in three and pneumonia in four cases.

Sale of Cattle :—

During the period under report 100 animals were sold for 36,302/-/-. The details are given in the accompanying statement.

Statement showing the sale of cattle from 1st July, 1950 to 31st March, 1951.

Serial No.	Name of Purchaser	Cows		Bull		Young Bulls		Heifers		Total Cattle	
		No.	Amount	No.	Amount	No.	Amount	No.	Amount	No.	Amount
			Rs.		Rs.		Rs.		Rs.		Rs.
1	Director of Live Stock, U.P.	..	..	..	..	14	4,020	..	..	14	4,020
2	Army Headquarters, Western Command, New Delhi.	8	4,880	1	445	1	310	10	5,000	20	10,635
3	Supdt. Cattle Research Station, Jubbelpore.	5	590	..	..	3	320	..	..	8	910
4	Director, Animal Husbandry, Bihar.	..	..	..	..	22	9,155	8	4,000	30	13,155
5	Shri Thakur Dass, Sadda Bazar, Karnal.	4	778	..	..	..	..	..	..	4	788
6	Sardar Diwan Singh, Karnal.	1	117	..	..	..	..	..	..	1	117
7	Shri Ram Singh, Karnal ..	1	101	..	..	..	..	..	..	1	101
8	Shri Dave-Ki-Nandan, Karnal.	1	171	..	..	..	..	..	..	1	171
9	Director, Animal Husbandry, U.P.	..	..	..	..	21	6,415	..	..	21	6,415
	Total ..	20	6,637	1	445	61	20,220	18	9,000	100	36,302

PROGRAMME OF WORK FOR 1951-52

Work will be continued on the lines mentioned in the report except for cattle breeding section. The following new items will also be included :—

1. Varietal trials of Jowar, Cotton and Linseed.
2. Paddy cultural experiment involving different methods of sowing.
3. Cropping of paddy after paddy in the same season.
4. Paddy-wheat rotational-cum-manurial experiment.

REPORT OF THE DIVISION OF BOTANY (INCLUDING BOTANICAL SUB-STATION, PUSA FOR THE YEAR 1950-51)

BY

(DR. N. PARTHASARATHY)

The research activities of this Division are directed mainly towards testing and devising methods and techniques making for efficient plant breeding with a view to evolving superior varieties of crop plants ; to this end fundamental researches are also undertaken in related sciences, like plant genetics, cytology, physiology and systematic botany. Special attention is devoted to basic problems of all-India importance such as breeding for resistance to diseases and pests and for hardiness to adverse conditions of soil and climate. Collaborative work, mainly involving exchange and evaluation of plant material and information, is done with the state departments of agriculture in India, foreign countries and international organisations like the F. A. O.

The results obtained in the main lines of work carried out in the different Sections of the Division are outlined below :—

PLANT BREEDING AND GENETICS

Breeding for rust resistance in wheat :—

This work, which is being done at Delhi and Simla as part of the Co-ordinated Wheat Rust Control Scheme financed by the I. C. A. R., aims at producing high yielding, rust resistant wheats for the hills and plains of India.

A total of 434 selections bred for combining resistance to all the three rusts with agronomically-useful characters was under study at Simla and a number of further promising selections have been made ; some of these are ready to go into replicated yield tests next year. In a preliminary trial conducted during the year at Simla with 26 promising rust resistant selections, 4 selections outyielded even N. P. 770 and Pb. 253, the best improved varieties for this tract, which were used as controls. These results will be confirmed by further trails.

A large number of promising, rust resistant selections were made at Delhi in hybrid progenies obtained from crossing suitable Indian varieties with foreign rust resistant types like Gabo, E. 220 and Charter. In some of the crosses, three to four generations were raised, consecutively during the year. In small-scale trials at Delhi with ninteen black rust resistant selections which included isolates from the cross W. 245, some appeared quite promising although during the year under report, when the field incidence of the rust was rather negligible, none of them outyielded the controls.

The work on breeding rust resistant wheats was commenced at Pusa (Bihar) under the Co-ordinated Wheat Rust Control Scheme.

Wheat varietal trials :—

(*a*) *New N. P. wheats.*—The trial of the twelve newly-evolved N. P. wheats of the 700-series was conducted at 24 centres in the wheat growing tracts of India with the co-operation of the respective state departments of agriculture. Some of these varieties maintained their superiority

over the locals, with regard to yield and tolerance to the rusts, at a majority of the centres of trial. The promising varieties include : East Punjab, Delhi, West U. P. and Rajasthan—N. P. 711,715, 718, 758, 760, 764 ; Allahabad, Kanpur and Attara—N. P. 710, 715, 718 and 720 ; East U. P., Bihar and Bengal—N. P. 710, 720, 775 ; Madhya Pradesh and Madhya Bharat—N. P. 710, 715 and 720 ; Hyderabad 710, 715, 760 ; Saurashtra—N. P. 710, 718, 760. The Department of Agriculture of Bihar and U.P. and the Institute of Plant Industry, Indore, have taken steps to multiply the seed of some of these varieties for distribution to growers in their respective areas.

(*b*) *Some exotic wheats.*—Small-scale trials were conducted at Delhi, for testing the general performance and resistance to the rusts under natural conditions of their incidence, with fifteen foreign wheat varieties, which included Saunders from Canada, Frontiera from Brazil and some types from Afghanistan, Kenya etc. ; none of them, however, appeared particularly promising.

Description of wheat varieties for the World Catalogue of Genetic Stocks.

Observation on a number of morphological, physiological and economic characters were recorded on plants in replicated sowings of 100 wheat varieties which are being described for the F. A. O. catalogue. A number of these varieties appear promising as regards yield, resistance to the rusts and to lodging and hence would be very useful as breeding material.

Breeding rust resistant linseed (*Linum usitatissimum*)

The results obtained in a replicated trial conducted at Delhi with the 35 newly-evolved, rust-resistant strains confirmed again the distinct superiority of some of them as regards yield, rust resistance and oil content over the N. P. types under distribution. The salient results are summarised below :—

Strain	Yield per acre in mds. (*Calculated*)	Oil content (%)
R. R.39	23·0	42·8
R. R. 204	22·5	44·3
R. R. 67	20·0	47·3
R. R. 38	19·0	47·1
R. R. 40	18·0	47·1
N. P. 12 (Control)	16·5	*41·6*

Similar trials were conducted at 11 centres in 6 states : the results are awaited.

Despite their high degree of rust resistance, most of these hybrids are rather late-maturing under conditions obtaining in Madhya Bharat and Madhya Pradesh. One hundred and four very promising, early-maturing, rust resistant strains have therefore been obtained from crosses between these and some very early types from Bengal ; their performance will be further studied.

Thirteen promising dual-purpose strains, some of which have significantly higher oil content than flax, have been obtained from linseed-flax hybrids. These are useful both for seed and for fibre. Seeds of these have sent for field tests to a number of states and samples of fibre to the Jute Technological Institute, Calcutta, for technological evaluation ; the results are awaited.

Breeding disease resistant safflower (Carthamus tinctorius) :

With a view to obtaining disease resistant, economic varieties of oil-yielding safflower, crosses have been attempted between some N. P. types, two Nebraska strains resistant to rust (*Puccinia carthami*) and a wild exotic species, *C. lanatus* which was found to be resistant to the rust and immune from *Cercospora carthami.*

Breeding wilt resistant pigeon-pea (Cajanus cajan) :

Eight wilt resistant varieties, which included N. P. types 41 and 80, one type from Burma (N. E. 40-6) and five hybrid derivatives and were under performance trial at Delhi, gave very encouraging results as regards both yield and wilt resistance. The salient yield data are given below :—

Strain	Yield per acre in mds. (*Calculated*)
) 16-17-2	33·5
' 15 Pusa	29·7
N. E. (40-6 (Burma)	28·4
N. P. (80)	26·7
N. P. 41	26·1

Some high-yielding pungent and non-pungent varieties of chilli

A number of pungent and non-pungent varieties and hybrid derivatives were under yield trial at Delhi, Karnal and Pusa. N. P. 46A, Hybrid 5-1-5 and Goa 20-1, among the pungent varieties, and N. 449, among the non-pungent ones, gave by far the highest yields.

Breeding tobacco (Nicotiana rustica) with high nicotine content for commercial utilisation—

Yield trials conducted at Delhi with a number of newly-evolved promising selections possessing high contents of nicotine confirmed last year's observations regarding the superiority of selections Nos. 19 and 20. Gratifying results were obtained from S. 20. seedlings and which were distributed to many growers in Delhi State under the Delhi Intensive Cultivation Scheme.

Breeding tomato varieties combining earliness, high vitamin C content and improved flavour.

(i) Yield trials

(*a*) *At Delhi.*—Eight newly-evolved hybrids and seven commercial varieties were under the replicated yield trial ; the plants were spaced at $2\frac{1}{2}' \times 1\frac{1}{2}'$ and $2' \times 1'$. The data obtained are briefly summarised below :—

Variety	Maturity	Total yield (Calculated) per acre in mds. during November—January		Early yield per acre in mds. (during November only)
		$2\frac{1}{2}' \times 1\frac{1}{2}'$ spacing	$2' \times 1'$ spacing	
Hyb. 3	Early ..	411	457	208
Hyb. 4	„	272	347	772
Hyb. 9	„	385	371	270
Sioux	Fairly Early	366	464	168
Red Cloud	Do.	367	497	186
Dessi Dickson	Medium ..	400	614	155
Marliana	Do.	444	495	98

The closer planting thus appears to be the more advantageous one. While hybrids Nos. 3, 4 a 9 gave high early yields, hybrid 3, possessing medium sized fruits, compared more or less favour with the highest yielding Desi Dickson in total yield ; the latter variety, however, did not give h early yield. The vitamin C content ranged between 49·9 and 62·4 mgm. per 100 gms of fresh fr in the hybrids as against 30·0 to 40·0 mgm. in the commercial varieties, excepting Earliana and American variety Hy. 8, which contained 54·1 and 47·8 mgm. respectively.

Hybrids Nos. 2 and 6, bred for high sugar content, showed about 4·24 per cent of total sug in the fresh fruits. Hybrid 6 has attractive rich red, cherry type fruits.

(*b*) *In other states.*—Seeds of 8 hybrids and 13 commercial varieties were sent for trial to centres in the different states. Among the new hybrids, Nos. 4 and 9 gave good early yields invariab at all the centres and, in some cases, also gave higher total yields than the locals. Of the introduc commercia varieties, Sioux, Earliana, Devlin's Choice and Porter's Pride did very well ; Sioux a Davlin's Choice have been particularly appreciated for the size and shape of their fruits.

(*ii*) *Study of varietal collections*

A large collection of indigenous and exotic tomato varieties was grown and studied at Delhi three periodical plantings for assessing their suitability to the different crop season, *viz.*, the wi crop, the summer crop and the late summer crop. In the winter crop, sown in July-August, Australian variety, Q1, (a selection from the American variety Sioux) gave a superior performance Sioux. In the summer crop, sown in November-December, the Tasmanian varieties, Australian P liana and Nystate, appeared to be the best. In the late summer crop (sown in February-M in which the fruiting season extended well until the end of June, the varieties Pearson, Sioux, De Choice and Desi Dickson did remarkably well and better than any others during the hot weat Desi Dickson was conspicuously free from the common hot weather disease of tomato causing ne of leaves and stem.

Hybrid Maize.—This work is being done under a scheme financed by the I. C. A. R.

Seventy-three Indian and 17 foreign open-pollinated varieties were tested in a replicated tr trials with Pusa Yellow-2 as the control. Among these Bidar, Jarvis Golden Prolific, Tipakhia, M 3, Panjab 22, Pusa 14 and Meerut Yellow stood out as high yielders.

Of the eight Australian single crosses tested for yield, some (especially those involving in No. 23 as one of the parents) did very well.

Seeds of 36 double-cross hybrids, received from the F. A. O. and the United States Depart of Agriculture, together with those of 4 Australian and 5 Canadian hybrids were planted for t at 20 centres in India. The crops were reported to have failed at 5 centres. The results from other 15 centres showed that, while different hybrids stood first in yielding ability at different cent a few among them were prominent as high yielders over a large range of centres. Some of these Dixie 11, U. S. 13, N. C. 27 and Indiana 252A. The Canadian hybrids were, in general, too early relatively poor yielders. Among the Australian hybrids, Q. 739 was outstanding for high yield number of centres.

Seeds of ten hybrids supplied by an American commercial organisation, the United Hybrid Co ers Association, were put under trial at Delhi, Karnal and Simla. Some of them gave yields higher than those of the American hybrids received from the F. A. O. Unfortunately, inbred lin these hybrids, those of the F. A. O. and the other hybrids, are not open to the public for use in production of hybrid seed.

About 700 inbred and about 300 top-crossed lines were under study : 170 single crosses h been made between the most suitable among them.

Hybrid onion.—A collection of Indian and foreign varieties of onion were under study especially, isolating male-sterile lines which would be useful in the production of hybrid onions.

CYTOLOGY AND CYTOGENETICS

p improvement through induced autopolyploidy

The work on the colchicine-induced autotetraploids of some oleiferous *Brassicae*, sessame, linseed n and chilli was continued particularly with regard to effecting improvement in their seed fertility. *Brassica*, a number of *elite* bulk populations of autotetraploid *toria* (*B. campestris* var. *toria*), ained by the pedigree mass selection method and grown in isolation plots, showed a marked increase he frequency of highly fertile plants than was found when improvement in this crop was sought e made by the method of single plant selection. A small scale yield trial, conducted with one of e *elite* populations and the corresponding diploid population, was unfortunately damaged by st attack. Observations were recorded of the C_2 progeny of autotetraploids obtained by colchicine ment of open-pollinated seed of the sessame type, N. P. 7. These plants while not yet comparing rably with their diploid progenitor in respect of seed yield, were markedly superior in growth, of fruits and the number of good seed per fruit to autotetraploids obtained previously in this ion from the type N. P. 6. The initial diploid material of N. P. 7 was found to be heterozygous. therefore perhaps accounts for the increased fertility observed in the autotetraploids of N. P. 7 mpared to that in autotetraploid N. P. 6. In linseed, it was interesting to observe that autotet- loids obtained from different strains showed differences in their behaviour, regarding plant growth seed fertility, as compared to the corresponding diploids.

lisation of wild relatives in crop improvement

(*i*) *Breeding disease resistant sesame.*—Twenty-one selections obtained finally from the hybridisa- of the cultivated *til* (*Sesamum orientale*, $2n=26$) with a wild related species, *S. prostratum* 32) showing hardiness and resistance to the phyllody disease of sesame, were under a replicated trial at Delhi. Some among them outyielded the best among the controls by about 20 to 45 ent and also showed higher oil content. These selections will be tested in other centres outside hi during the next season.

The chromosome numbers of two wild African species, *S. alatum* and *S. angolense*, and a related s, *Ceratotheca sesamoides*, were determined as being 2n=26, 32 and 32 respectively. These are g used for hydridisation *inter se* and with the cultivated sesame for cytogenetical studies.

Breeding disease resistant wheat varieties

Clones of the sterile F_1 hybrid of *Triticum dicoccum*×*T. monococcum*, both of which species are y rust resistant, were treated with colchicine for obtaining the amphiploid. Treatment of s of this hybrid by the " capping " method, using 0·25 per cent aqueous colchicine, gave the best lts : 30 seeds were obtained from which amphiploid progenies will be raised for use in further ding work.

Cytogenetics of wheat-rye hybrids (*Triticale*)

Variable chromosome numbers, from 42 to 56, showing irregular behaviour at meiosis, were found e plants of a culture of *Tricicale*, the seeds of which were originally obtained from Cambridge land) few years ago ; another culture, isolated from this material, appeared to be completely t-like, containing $2n=42$ chromosomes which underwent normal meiosis. This is believed to been caused by natural crossing of *Tricicale* with wheat and subsequent elimination of rye nosomes.

(4) *Lady's finger* (*Abelmoschus esculentus*)

A wild species related to Lady's finger (*Bhindi*), not described so far, has been collected and studi from several places in India and designated *Abelmoshus tuberculatus* Pal *et* Singh. This new speci which appears to have $2n=54$ chromosomes unlike the $2n=130$ chromosomes in *bhindi*, has show pronounced resistance to the common virus disease of cultivated *bhindi* and is being utilised for bree ing disease resistant varieties of that crop.

(5) *Improvement of cytological technique*

Work was in progress on the use of 8-oxyquinoline and-bromonaphthalene. These chemic appeared to be useful in obtaining good preparations of mitosis in root tips in which the structur characteristics of chromosomes were brought out relatively more clearly.

CROP PHYSIOLOGY

Study of drought resistance in wheat.—A pot culture and a field experiment were conducted with varieties. In the former, conditions of intermittent drought were artificially given and the resu obtained confirmed the previous ones that varietal differences as regards spikelet number and gra size persisted under different conditions of drought. No conclusive results could be obtained from t field experiment because (*a*) hardly any moisture stress developed in the fields presumably owing rise in water table and (*b*) the crop lodged severely due to rainstorms in March.

Physiological analysis of factors concerned with yield.—The contribution of dry matter from pho synthesis in the ear to grain yield was found to be significantly higher in the varieties, N. P. 52 and N. 710, than in N. P. 165, thus confirming the results obtained in the previous years ; contributions fr reserves and from photosynthesis in leaves and stem to grain yield did not, however, differ with variety. In an attempt to find out the cause of this varietal difference with regard to the contribut of dry matter from photosynthesis in the ear, the rates of yellowing of leaves, stems and ears and presence or absence of awns on ears were studied. None of these, however, could wholly account them. The investigations will be further continued.

Study of the influence of light and temperature.—In an experiment with three sowing da the 6th and the 25th November and the 15th December and five varieties *viz.*, Baluchistan 16, C2 CPH 47, N. P. 165 and C. 591, it was found that CPH 47 and Baluchistan 16 performed poorly in late sowings, whereas C. 591 performed better and N. P. 165 and C. 228 were not so much influen by sowing time. These results were in conformity with those obtained last year.

Physiological aspects of plant nutrition.—In an experiment with three levels of nitrogen, 0·20 and 40 lb. per acre, and three varieties, *viz.*, N. P. 165, N. P. 710 and N. P. 52, the results obtai confirmed those of last year that N. P. 710 absorbed a larger quantity of nitrogen than the other t varieties and that its utilisation of nitrogen (dry matter per unit amount of nitrogen taken up) just as good as, or perhaps less efficient than, that of the other two varieties.

Plant hormones.—Four varieties, *viz.*, N. P. 165, C. 228, N. P. 52 and Agra Local, were tre with 0. 20 and 200 ppm of indole-acetic acid in aqueous solution. The cut leaf tips were dipped in solution ; the treatments were started 3 weeks after sowing and continued for 8 weeks. The produc of tillers as well as of ears was stimulated in Agra Local and in N. P. 52, the treatment with the 20 p solution increased the number of fertile spikelets.

In another experiment, the effect of the application of 2, 4-D to the soil on the growth of 10 wh varieties was studied. Abnormalities concerned with the unfolding of leaves, differentiation of lam and sheath, differentiation of the spikelets as well as their alignment with reference to the rachis its branches were recorded ; these abnormalities were common to all the varieties. There appeared

e, however, appreciable differences among the varieties in respect of the percentage of reduction in rain yield due to the treatment ; Agra Local yielded the highest and significantly more than all the ther varieties which, among them, did not vary appreciably. The results obtained last year had dicated the existence of a correlation between drought resistance and tolerance to 2, 4-D in the culture edium : the present observations did not confirm these results. However, the fact, that diverse haracters could be influenced by indole-acetic acid and 2, 4-D, indicates the possibility of not only ntering the growth pattern of a variety but also of making a new approach towards elucidating of the auses of different varietal characters. In a field experiment with wheat, control of weeds by means f hand-weeding with khurpi, and by spraying with methoxone at the rate of one lb. per acre rain yield increased by nearly 5 mds. per acre.

Lodging in wheat.—An experiment with 4 varieties, *viz.*, N. P. 12, N. P. 710, N. P. 165 and C. 518 nd combinations of nitrogen and potash was undertaken. The first two varieties are known to lodge ore easily than the other two Nitrogen reduced breaking strength and dry weight per unit length f the basal internode while potassium tended to arrest this effect of nitrogen. The basal internode f C. 518 had a higher silica content than that of N. P. 12. Nitrogen appeared to depress the silica ontent whereas potassium had the opposite effect. With regard to morphological characters the llowing peculiarities were noted ; In C. 518, the breaking strength and weight per unit length of the asal internode were low, whereas its silica content was high : the latter characteristic and low top- eight seemed to account for its relative resistance to lodging. In N. P. 165, the breaking strength nd weight per unit length of the basal internode were high, its silica content was medium and the op-weight was also medium. N. P. 710 differed from N.P. 165 in respect of top-weight only which was latively higher and thus made it susceptible to lodging. In N. P. 12, the breaking strength, eight per unit length and silica content of the basal internode were uniformly low and besides the top- eight was high. It would appear that the top-weight must also be taken into consideration along ith morphological attributes of the basal internode in accounting for resistance to lodging.

SYSTEMATIC BOTANY AND PLANT INTRODUCTION

Systematic Botany.—Considerable amount of advisory work dealing with botanical nomenclature, cal names and systematic identification of a large number of plant specimens received from all over e country was attended to. The work on the survey of the weed flora of the Institute was continued 283 specimens of local plants and weeds were added to the herbarium. A collection of sweet potatoes, omprising 50 varieties, was studied and a tentative scheme for their systematic classification was orked out : some observations on flowering in a few varieties at Delhi were recorded.

Plant Introduction.—A total of 462 samples of seeds and other planting materials, comprising reals, millets, pulses, oil and fibre plants, vegetable and root crops, narcotics, medicinal plants asses and legumes for fodder and forage and wild relatives of crop plants, were received from various reign countries bringing the entire collection to 3121 items. Collections were also made of Indian rieties of several crops, including their wild relatives, by correspondence and by surveying various acts. The material was grown at Delhi and also at some of the State Agricultural Experiment Station.

The following is an account of observation on some of the more important materials :—

1. *Subsidiary food crops*

(*i*) *Sweet potato.*—The collection comprising 60 varieties was given further trial. Fifteen selected rieties were grown in a replicated yield trial. The two Chinese varieties, F. A. 17 and Tie-shin-Tun, ve the best performance yielding 194 and 126 maunds respectively, of tubers per acre *i.e.*, about 0 per cent and 50 per cent more than the best local variety, under average cropping conditions. The orts received from the other states indicate that these varieties have done better than the locals in eral places. This shows that these varieties have a wide adaptability.

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(*vi*) *Other root and tuber crops.*—The potato Yam or *Suini* (*Dioscorea esculenta*) gave a calculated acre yield of 146 maunds. This yam appears to be suitable for growing as a summer crop (April to November) under Delhi and similar other conditions.

B. *Other crops*

(*i*) *Soybean* (*Soja max*).—The varieties selected last year for grain and fodder purposes were given a further trial. For grain, a Chinese bold-seeded bush variety (E. C. 829-4), which yielded about 15 maunds per acre, was selected; when sown in early July, it matured in about 90 days. This variety can, therefore, be grown between July to September and the same piece of land can be made available for the subsequent *rabi* sowings. Two viny varieties, Afghanistan 2686 (I. C. 211) and I. C. 203, are considered useful as a source of supply of green fodder until about the end of November.

(*ii*) *Cowpeas.*—A collection of 90 varieties was under observation. For grain, an early variety—New Era, obtained from Madras State (Originally a foreign introduction) and another variety, E. C. 1095, from Sudan were found to be high yielding and very promising. Branco, a dwarf variety from Brazil, was observed to be suitable for growing as a summer crop, *i.e.*, during May and June.

(*iii*) *Peas.*—Zelka Marrowfats, a variety from Holland, showed the growth habit of the popular variety N. P. 29 and gave high yields of both green peas and grain Seeds of the American early variety Early Badger, were multiplied for trials.

(*iv*) *Mung* (*Green Gram*).—A collection of varieties of China *mung* recently grown in Bombay, Madras and the Panjab and the early variety, Type 1, from Uttar Pradesh were tried at Delhi during May and June as a summer catch crop. The U. P. Type 1 matured in about 60 days and gave a yield of about 10 maunds per acre as an irrigated crop; the China *mung* varieties did not appear quite so promising.

(*v*) *Sunflowers.*—A number of foreign varieties were under trial at Delhi during *rabi*. The Canadian hybrid, Advance—a dwarf variety, gave a good performance and showed a high oil content of 32·5 per cent.

(*vi*) *Green manure crops.*—A set of *kharif* legumes, comprising exotic and indigenous species and varieties belonging to eleven genera, was studied for total green matter and for root nodule formation. *Guar* (*Cyamopsis*) and sannhemp (*Crotalaria*) gave the highest yield of green matter, whereas *Sesbania bispinosa* was the best in nodulation; good nodulation was also observed in a variety of velvet bean (*Stizolobium*) from Brazil and in *Sesbania macrocarpa* obtained from the U. S. A.

(*vii*) *Fodder and forage legumes.*—Three perennial trailing legumes, *Indigofera endecaphylla* (Ceylon), *Desmodium intortum* (Gautemala) and *D. uncinatum* (Australia), which grew very well at Delhi during the summer months, are considered useful for pasture; *Indigofera endecaphylla* was particularly fast and vigorous growing.

(*viii*) *Grasses.*—A Brazilian trailing grass, *Bothriochloa insculpta*, was observed to be quick growing during the summer and rainy seasons indicating its suitability for pasture. As a *rabi* fodder, a high yielding strain of *Avena strigosa* from Uruguay, which remained green until the middle of May, appears promising and was multiplied for further trial. A total of 1518 samples of seeds of a number of crops was supplied to a number of scientific workers and institutions in the country. Some of the plant materials of foreign origin were also distributed for trial in a number of stages in India.

Botanical Substation, Pusa

This auxiliary substation of the Botany Division continued its research and other related activities which included the following: (*i*) plant breeding with special reference to disease resistance

wheat, linseed, *rahar*, etc. and trials of selections and of the newly-evolved varieties under the conditions of soil and climate obtaining in north eastern India, (*ii*) maintenance and trials of valuable indigenous and exotic collections of crop varieties and related species and genera imported by the Botany Division, (*iii*) maintenance and multiplication of pure foundation stocks of improved N. P. types for distribution to growers in this tract.

The Permanent Manurial and Rotational and the New Manurial experiments were conducted for the Agronomy Division. One Research Assistant of the Chemistry Division and one Senior Scientific Assistant of the Entomology Division, who were transferred to this Substation, helped in looking after the experiments of those Divisions. With the appointment of the Assistant Wheat Breeder at Pusa under the Co-ordinated Wheat Rust Control Scheme, the work on breeding for rust resistance was much augmented.

In the major yield trial conducted with the 12 new wheats belonging to the "700-series" N. P. 718 and N. P. 720 stood out as the best yielders. Ten pungent and five non-pungent varieties of chilli were under replicated trials. Hybrid 5-1-5, Coa 20-1 and N. P. 46-A among the former and R. 449 among the latter gave remarkably high yields. The other investigations carried out included preliminary trials of rust resistant strains and exotic varieties of wheat, wilt resistant *rahars*, maize hybrids, rust resistant linseeds, some Chinese types of paddy and some potato and tomato hybrids and plant introduction materials received from Delhi.

PROGRAMME OF WORK FOR 1951-52

1. Improvement of wheat with special reference to resistance to rusts and yield.

2. Trials of newly-evolved improved varieties of crop plants, such as wheat, linseed, tomato sesamum, etc. at this Division and in the different states.

3. Investigations on the utilisation of hybrid vigour in maize and onion.

4. Induction and study of polyploidy in crops, like brassica, linseed, sesamum, chilli and gram, as a method of crop improvement and trial of some of these ploypoids.

5. The study of the wild relatives of crop plants and their utilisation in breeding superior crop plants.

6. Investigations on the improvement and application of cytological technique.

7. Studies on drought resistance in wheat : studies under pot and field conditions will be continued.

8. Physiological analysis of factors concerned with yield : studies on the contribution of different plant organs to grain yield will be continued.

9. Influence of light and temperature on development and growth : work on raising more than one generation (wheat crosses) in a year will be continued.

10. Plant hormones : Investigations on the role of hormones in the growth and development of different varieties of wheat, as also on their usefulness in weed control, will be continued.

11. Physiological aspects of plant nutrition : studies on the relation between varietal differences in nutrient uptake and plant development will be continued.

12. Lodging in wheat : investigations on factors concerned with lodging.

13. Introduction, main tenance and study of plant collections.

14. Trials of important collections, like those of hybrid maize, sweet potatoes, etc. at Delhi and in the different states.

REPORT OF THE DIVISION OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY FOR THE YEAR 1950-51.

(Dr. S. P. Raychaudhuri)

SOIL CHEMISTRY

(*a*) *Agricultural Chemistry.*

1. *Effect of soaking seeds in nutrient solutions on the yield of crops* :—(M.A. Idnani and B. V. Subbiah, 1950).

Soaking of wheat seeds in 0·5 molar solutions of ammonium nitrate and ammonium phosphate gave increased yield of wheat by 75% and 34% respectively. Soaking of sannhemp seeds in 0·5 molar solution of potassium phosphate increased the green yield by 19%.

2. *Comparative value of different cuttings of berseem* :—(B. V. Subbiah, 1949).

From the mineral and protein points, the 3rd cutting of berseem was found to be the best but the yield of the 4th cutting was somewhat more than that of the 3rd cutting. In the 5th cutting the yield again decreased. As regards manuring Am. phosphate (80 lbs. P_2O_5) was better than Am. sulphate supplying equivalent quantity of N. The yield of the crop from superphosphate @ 80 lbs. P_2O_5 per acre was as good as from Am. phosphate in the last 3 cuttings, while the yield of the first 2 cuttings was higher with Am. phosphate.

3. *Comparative manurial value of different rabi legumes* :—(B. V. Subbiah and R. K. Chibber 1950).

The results of this trial show that the *rabi* legumes tried (methra, senji, gram, peas, lentil and berseem) generally gave increased yields when fertilised with phosphate. The total amount of nitrogen and green matter buried as green manure was highest in senji (135 lbs. N in 25260 green matter), followed by peas (69 lbs. N in 17550 green matter per acre).

4. *Cation-anion relationships in plants and seeds* :—(B. V. Subbiah, 1950).

The chemical composition of seeds of different plants indicates that the ratios of the sum of the cations Ca+Mg+Na+K in equivalents and anions $NO_3+PO_4+SO_4$ in equivalents is fairly constant (about 0·2) for different types of seeds. It was further found that the cation-anion ratio of berseem and other plants varies with the pH of the sap of the plants at different stages of growth.

5. *Manurial value of wild leguminous plants* :—(M. A. Idnani and R. K. Chibber, 1948).

Analysis of the wild leguminous plants of *Tephrosea purpurea*, *Cassia obtusifolia* and *Cassia occidentalis* showed that at the flowering stage, the content of manurial ingredients in the whole plant is of the order of 1·99—3·24% N, 0·67—1·13% P_2O_5 and 2·37—3·84% K_2O. The leaves alone were richer with ranges of 3·09—5·05% N, 0·70—1·35% P_2O_5 and 3·18—4·32% of K_2O. Manurial experiments with leaves of *Prosopis juliflora*, *Tephrosea purpurea Cassia occidentalis* and *Crotalaria medicoginea* on wheat gave increased yields varying from 160% to 325% over control.

6. *Availability of N in tea waste* :—(M. A. Idnani and M. K. Roy, 1950).

Tea waste containing 3·54% total N gave no increase in the yield of wheat when applied at 50 lbs. N per acre. In nitrification experiments only 18% of the nitrogen nitrified. This low availability of nitrogen was found to be due not to the presence of tannin or other toxic substances but to the process of roasting of the leaves to which they are subjected. Treatment with steam or sulphuric acid increased its nitrifiability to 40%.

7. *Conservation of human urine* :—(M. A. Idnani, 1948).

Experiments on the preservation of urine in various absorbing materials showed that while con lderable losses of N may take place on moist storage, saw dust and tea waste proved to exceptions to his. Addition of 15% saw dust to soil, ash, charcoal powder and 1% sulphuric acid to leaves an aste paper acted as preservatives of urine without loss of nitrogen on storage.

) *Soil Chemistry.*

1. *Fixation of potash in Indian soils* :—(S. P. Raychaudhuri and I. D. Dharni, 1950).

The following four methods for potash fixation studies were worked out and some soils were xamined for their potash fixing power.

(*i*) Alternate wetting and drying, (*ii*) heating the soil, (*iii*) wetting the soils with water fol- owed by immediate treatment and (*iv*) partly wetting the soil and treating with potash salt after nterval of one hour.

Silica sesquioxide and silica alumina ratios indicated that Delhi soil contains mixture of mont- orillonite and illite minerals whereas Karnal and Pusa soils contain mostly Kaolinite type of ays.

Potash fixation was positive and was considerable in all cases except in the calcareous Pusa soil hen the soil was preheated. Base exchange capacity did not show any correlation with fixation apacity.

2. *Composition of tank silts* :—(A. Sen and B. Das, 1950).

Samples of tank silts from 37 villages from different districts of West Bengal were analysed for heir manurial value. The silts were found to be richer in plant nutrients than average soils and some f them could even be compared with Farm Yard Manure in respect to the nitrogen content. A onsiderable portion of the nitrogen was in the form of ammonia. They were all acidic in nature pH 5·05 to 6·07) and the samples were richer in fine fractions than ordinary soils.

3. *Studies on the nature of clay in reclamation of Saline Soils* :—(A. K. Das and S. P. Raychau- huri, 1950).

Profile samples of soil were collected from wheat fields of the Gheora and Qumaruddin villages n the Delhi District and from the Botany Division of the I.A.R.I. In all the cases, the water table as reached within 4-6 ft. from the surface. During the dry season soils at this depth were charac- erised by the presence of calcium carbonate nodules.

Data so far obtained indicate that all the soils were moderately alkaline (pH 7·5 to 9·0) and here was no regularity of changes in pH with the depth of the profiles. Soluble salts, mainly NaCl nd to smaller extent Na_2CO_3 varied from 0·5 to 1·2 per cent. The amounts of soluble Ca in the oils were small. Exchangeable Ca, however, comprised 60 to 75 per cent of the total exchange apacities which varied from 7 to 13 m.e. per cent. Permeabilities of the soils were highest at the op (0-6″) and they rapidly decreased with depth.

4. *Studies on the use of 8-hydroxy-quinoline for direct determination of Al, Fe, Ca and Mg* :—(R. . Chatterjee and S. P. Raychaudhuri, 1950).

It was observed that Mg could be separated quantitatively at a pH 8·2 and above, in the crys- alline precipitate having a composition $Mg(C_6H_6ON)_2, 4H_2O$. Al and Ca could be separated n a similar way at pH 6·8 and 9·2 respectively.

Using be an ammonium acetate buffer, Ca and Mg could be separately determined by controlling the pH from a mixture of Ca and Mg salts. Al and Mg could be similarly determined. Separation of Al and Ca and Al, Ca and Mg from their mixtures is in progress.

(*c*) *Soil Fertility.*

1. *Building up of soil fertility by phosphatic manuring of berseem : lysimeter studies* :—(S. V. Desai, A. B. Ghosh and S. P. Jain, 1945).

By adopting a cereal legume rotation berseem-cowpea-wheat-cowpea and by manuring berseem alone with 100 lbs. P_2O_5 as superphosphate high level of fertility is maintained as against unmanured berseem. Examination of leachates showed minimum loss of nutrients in legume rotation.

2. *Phosphoric acid requirement of Berseem in Karnal soil* :—(A. B. Ghosh and S. P. Jain, 1950).

Pot culture experiments carried out during the year with berseem using P_2O_5 in multiple doses of 50 lbs. upto 300 lbs. per acre indicated that Karnal soils are not deficient in P_2O_5. This corroborates the chemical analysis data showing percentage available P_2O_5 as 0·02 which is considered fairly good.

3. *Effect of continuous application of manures and fertilisers on reactions of calcareous soils* :—(Permanent Manurial Experiments at Pusa) (A. B. Ghosh, 1951).

Due to high lime content of the Pusa soil no appreciable difference was found in pH, even in soil continuously treated with ammonium sulphate.

(*d*) *Micronutrient.*

1. *Work on gram* :—

(*i*) *Top yellowing disease* :—(N. P. Datta and N. R. Datta Biswas, 1950).

Previous work had shown that (*i*) the top yellowing of gram was not associated with any pathogenic organism, (*ii*) total soluble salt was higher in soils around top yellowed plants than that in soils around healthy plants, (*iii*) the content of manganese in the diseased shoots was definitely lower than that in the healthy shoots. The object of the present study was to get further information on the problem and to find out the cause of the disease, by means of pot culture experiments in which the treatments were (*a*) control (healthy soil), (*b*) healthy soil in pot in contact with water placed in a pan (water table at 9-10″ from the surface), (*c*) healthy soil (total soluble salt 0·06%) + 0·04% salt of the composition as found in the diseased soil, thus making the total soluble salt to 0·1%, (*d*) healthy soil + 0·09% salt, the total soluble salt being 0·15%, (*e*) healthy soil + 0·14% salt, the total soluble salt being 0·2%, (*f*) diseased soil (0·68% total soluble salts) and (*g*) diseased soil washed to remove soluble salts partially. It was found that the plants in pots where water table was maintained developed definite top yellowing symptoms. Plants in pots containing healthy soil and in pots treated with 0·1% salt were healthy. During the period of growth two pots out of the five in the 0·1% series were provided with water table 9-10″ from the surface. The plants in these two pots developed top yellowing after sometime though the plants in the other three not so treated remained healthy. The leaves of plants in treatments (*d*), (*e*), (*f*) and (*g*) became yellow from the bottom, the crown remaining normal. This type of symptom is evidently due to salt injury.

(*ii*) *Manganese deficiency in gram : sand culture experiment* :—(N. P. Datta, 1950).

Symptoms of manganese deficiency were produced under pure sand culture conditions and were found to be different from the symptoms of top yellowing.

The above two experiments prove that top yellowing of gram is due to air-water unbalance in the root zone of crop and manganese deficiency in gram is different from top yellowing.

2. *Trace elements in grasses, forages, and concentrates* :—(N. P. Datta and N. R. Datta Biswas, 1950).

Pot culture experiment with grass "*Phalaris minor*" under five different treatments *viz.*, (1) control, (2) lime at 1 ton/acre, (3) amm on sulph. at 56 lbs. N/acre, (4) superphosphate at 80 lbs. P_2O_5 per acre, (5) muriate of potash at 100 lbs. K_2O/acre revealed a marked beneficial effect of superphosphate, while lime showed a depressing effect. The analyses of major nutrient elements in the grass samples under different treatments revealed that P and K of the soil were sufficiently adequate and fertiliser treatment seemed to have no marked effect on the uptake of such elements by the grass plants. Lime and ammonium sulphate treatments helped the grass plants in increased uptake of Ca and Mg.

3. *Minor element deficiencies in citrus* :—(I.C.A.R. Scheme). (K. L. Nayyar and K. B. Shome, 1946).

At Jullundur, Attari and Jamalpur mottling of leaves, and yellow interveral chlorosis with veins standing out green were observed in citrus leaves. At Tharsa (M.P.) only a few trees and at Ubali (M.P.) most of the trees were found to be affected with mottling of leaves. In all the above places diagnostic injections and sprays with micronutrient solutions (B, Cu, Fe, Mg, Zn) were conducted.

In Coorg at Hosacottay (lateritic soil) application to soil of F.Y.M. and artificials including micronutrients to diseased plants had not as yet shown any effect while at Horadur (red loam) the same treatment has markedly improved growth and vigour of the treated trees. This year trees in the old experiments have been treated again and a new experiment at Palur in the laterite zone started. Leaves and soils collected are being analysed. In Jullundur and Attari no difference could be found in the total contents of P_2O_5, Al_2O_3, Fe_2O_3, CaO, P_2O_5 and K_2O in the soils under healthy and diseased plants. Plant analysis shows that the diseased Malta leaves from Jullundur are lower in their contents of manganese than that of the corresponding healthy samples (Healthy 59 p.p.m., diseased 38 p.p.m.).

SOIL PHYSICS

1. *Studies on soil aggregates and soil moisture* :—(B. T. Mulwani, 1950).

Effect of different types of cultivation, manuring and cropping on the moisture holding capacities of soil and soil aggregation was examined.

(*i*) Examination of the ley farming area in the Agronomy Division revealed that the growth of mixture of some grasses made the soil more retentive of moisture.

(*ii*) Periodical observations taken in the cultivation experiments showed that the cultivation by bullock drawn implements was more effective in retaining soil moisture and also forming favourable soil aggregates (1-3 mm diam.) as compared to the cultivation by tractors.

PHYSICAL CHEMISTRY

1. *Electrochemical and mineralogical properties of hydrogen clays from typical Indian soils* :—(B. B. Roy and S. C. Das, 1949).

Studies on the electrochemical and minerological properties of hydrogen clays prepared from horizon samples of typical soil profiles from different localities for obtaining information on the development and genesis of these soils were continued.

(*i*) *Soil from the Institute Substation at Karnal* :—(B. B. Roy, 1950).

The silica-sesquioxide ratio of the clay fractions from the top horizon is 2 or slightly higher while it is somewhat less in the lower horizons. Non-exchangeable magnesium to the extent of 0·84 to 1·28% MgO is present upto a depth of 26 inches. Potentiometric titration curves show dibasic acid nature of the clays, specially in the lower layers, the ratio of the two base exchange capacities being almost equal to 2. The individual values are also low. The clay fraction consists mainly of kaolinite, but the top horizon upto 26 inches also contains some montmorillonitic type of minerals.

(*ii*) *Yellow Matasi soil from Labhandi* (M. P.) :—(B. B. Roy and S. C. Das, 1950).

The silica-sesquioxide ratio of the clay fraction from different horizons varies between 1·7 and 1·95. Non-exchangeable magnesium is present to the extent of 0·1% MgO in the top horizon (0-12″) and 1·3% in the lowest horizon (52-60″). The base exchange capacity increases down in the profile from 36 to 43 m.e. per 100 gm. clay. The viscosity buffer curve with NaOH has a flat run excepting for a slight maximum specially in the lower horizons. The lattice water is 10-12% while the adsorbed water is 6-8%. It is thus concluded that yellow matasi soil which lie adjacent to the black *kanhar* soil has kaolinite as the dominant constituent of its clay fraction, with some montmorillonite also occurring along with it, specially in the lower horizon.

2. *Properties of subfractions of hydrogen clay from black cotton soil* :—(B. B. Roy and S. D. Sinha, 1949).

Subfractions of hydrogen clay were prepared from the entire clay fraction of black cotton soil Padegaon (0-20″), by graded centrifugation by means of Sharples Supercentrifuge. The electrometric titration curves were all of the same type showing that the same mineral was present in the different gradations. The base exchange capacity, however, increased with diminishing particle size (from 50 to 80 m.e. per 100 gms. clay).

SOIL SURVEY

1. *Soil map of I.A.R.I. Farm* :—(R. V. Tamhane and B. S. Gupta, 1949).

The Soil Survey of the I.A.R.I. farm was completed. 19 profiles and 117 borings were examined. A soil map of the farm was prepared.

2. *Soils of Agricultural Substation, Karnal* :—(K. V. S. Satyanarayana, 1950).

The morphological features of the profiles and the analytical data of the soils reported last year show that the soils possess a close resemblance to the brown earths of Ramann and the ' brown soils' described by Joffe and Jhorpe. The soils of Karnal are placed under the world group as " a variant of brown earth ".

3. *Study of black soils of Narbudda Valley tract with a view to examine their suitability for irrigation* :—(R. V. Tamhane and T. L. Deshpande, 1949).

5 selected profiles were examined. The soil is mostly clayey, the clay fraction varying from 40 to 55% and the silt from 1·8 to 8·0%. As a result of study of the factors like porosity, permeability and chemical composition it has been found that the soils are suitable for irrigation purposes but since these are deep soils drainage provision will safeguard the soils against deterioration.

4. *Reconnaissance soil survey of the farm of Bopal Sugar Industries Ltd.* :—(R. V. Tamhane and S. C. Das, 1950).

The soils of the area come under black soil with clay content varying from 20 and 40%. The pH of the soils is between 7·5 and 8·2. The carbonate content varies between 0·6 and 4·3%. The soils are deficient in P_2O_5, the HCl soluble P_2O_5 varying between 0·04 and 0·05%. But HCl soluble Ca is fairly high, about 3 to 4%. The exchangeable calcium occupies nearly 80·0% of the base exchange capacity. The soils in general are very good for cane cultivation.

5. *Soil survey of the Central Potato Research Institute, Patna* :—(R. V. Tamhane, S. C. Das and D. P. Motiramani, 1950).

Major part of the area is sandy and sandy loam. pH varies from 6·2 to 7·7. Most of the soils are fairly rich in major chemical constituents but need addition of organic matter.

6. *Intensive cultivation Scheme, Delhi District* :—(K. V. S. Satyanarayana and R. V. Tamhane, 1950).

Soils and water of even villages Pudhela, Tilangpur, Qumaruddin Nagar, Keshopur, Rhenola, Shaffipur and Gheora were examined and maps of the villages showing broad soil classes were prepared.

7. *Rann of Cutch* :—(K. V. S. Satyanarayana, 1950).

The first reconnaissance soil survey of selected areas was carried out in April, 1947. During February, 1951, survey of the southern portion of Wagud tracts and the surrounding area of Rann was conducted. Profiles were examined at Sukhpur, Lakhapur, Rann area near Pipraia and Nanda bet. During the course of these studies it was found that there were pan formation at different zones.

8. *Study of saline soils of the Delhi State* :—(N. M. Nimgade and S. P. Raychaudhuri, 1950).

Two villages, namely Gheora and Qumaruddin Nagar were selected in the Delhi State for this purpose. The areas which showed heavy incrustation of salts were selected for the profile study. One profile from each village was taken.

Water sample from adjacent wells was not found to be suitable for irrigation due to high percentages of salt. The soils were found to be fairly rich in exchangeable sodium and addition of gypsum improved infiltration.

9. *Minerological Studies* :—(N. Sen, 1950).

(*i*) *Delhi Soil* :—The soils of the eastern side of the Delhi ridge appeared to have no relationship, in respect of the light and heavy minerals with the rocks of the ridge. It is suggested that these soils are of riverian origin.

(*ii*) *Black soils of Powerkheda, Chargaon, Bhopal and Nagpur* :—Minerological analysis of the fine sand fractions of these soils show that the major part have originated from trap rocks and about one fourth of the soil appear to have been transported by water or wind, from rocks of non-Trappean origin.

Examination of moorum from Bhopal and weathered trap from Nagpur suggests that the montmorillonite of the clay complex of the black soils may be due to the weathering of chlorophcite-palagonite group of minerals occurring in the basalts.

ORGANIC CHEMISTRY

1. *Oils and oilseeds* :—(B. G. Chatterjee, R. G. Sehgal and K. C. Gulati, 1950).

A rapid method for the determination of oil in oilseeds and oil cakes has been developed. Nearly 350 strains of oilseeds supplied by the Division of Botany were analysed by this method. About 0·5 gm. of sample has been found sufficient for the analysis. Eight to ten samples of seeds can be analysed in duplicate in a working day of eight hours.

The methods consists in grinding the sample to fine powder with glass powder washed with acid and anhydrous sodium sulphate. The powder is taken in benzene, refluxed and filtered in a measuring flask. The solution is made up with benzene and a known volume evaporated under vacuum. From the oil left behind, percentage is calculated.

2. *Natural Insecticides* :—(B. G. Chatterjee and K C. Gulati, 1950).

A rapid method of extraction of nicotine in tobacco by steam distillation and its subsequent estimation by spectrographic method has been developed in collaboration with the Physics Section.

The method is based on distillation of the sample in an all glass apparatus with super-heated steam under positive pressure. The absorption spectra of the distillate after proper dilution is taken in a Spelkker ultraviolet spectrophotometer. The band is read at 2600 A° region.

3. *Synthetic Insecticide* :—(K. C. Gulati, B. G. Chatterjee, Ved Vyas, and Krishan Kant, 1950).

Investigations are being continued on Organic thiocynates (which gave promising results in the previous year) ; organic phosphorus compounds and terpene alcoho and ethers.

4. *D.D.T. Scheme I.C.A.R.* :—(R. S. Dewan and K. C. Gulati, 1949).

Formulations were prepared in the form of (*i*) 35-40% emulsifiable concentrates which can be diluted with water on the spot, (*ii*) Wettable insecticide dust with gypsum as carrier. Six dosage of DDT varying from 2·5 to 40 lbs. per acre were tested against termites in wheat and sugarcane fields. They checked the plant damages to a marked extent, the higher dosage being more effective. Increase in the yields in the treated plots over the control were significant, except in the case of treatment with 2·5 lbs. of DDT per acre.

SOIL MICROBIOLOGY

1. *Utilisation of indigenous phosphate* :—(N. D. Vyas, 1950).

Effect of superphosphate, bonemeal, Trichi nodule and Singhbum phosphate on the yield of sannhemp or a green manure crop and its subsequent effect on wheat was investigated. The following figures show the yield of sannhemp and of following green manured wheat.

Yield of crop in gms. per pot (average of 4 pots)	Control	Superphosphate	Bonemeal	Trichinodule	Singbhum phosphate
	gm.	gm.	gm.	gm.	gm.
Sannhemp	78	90·5	107·9	98·6	87·6
Wheat	11·08	15·16	14·69	16·67	15·63
Increase of wheat yields over the control ..		36·8%	32·6%	50·4%	41·1%

The figures show that indigenous phosphates like bonemeal, Trichinodule and Singbhum phosphate could be used beneficially through sannhemp.

2. *Study of Azotobacter species found in different soils of India* :—(S. V. Desai, N.D. Vyas and S. C. Biswas, 1950).

Azotobacter species isolated from soils of different places showed varying nitrogen fixing power. One important point worth noting is that acid soils of Travancore with pH 3·7 contained Az. species and fixed 4·9 mgm of nitrogen per gm of mannite in 100 cc. of Ashby's medium.

3. *Sulphate Reduction* :—(S. V. Desai and S. C. Dutt, 1950).

Examination of soils of Rann of Cutch showed some pan formation and also presence of gypsums. Samples of soils of different horizons were examined for the presence of sulphur reducing organisms by inoculating in Von Delden's solution. Large amount of H_2S was produced by the organisms of the soil near the pan formation.

4. *Nitrogen fixation in soils* :—(I.C.A.R. Scheme)—(N. D. Vyas and A. N. Sen, 1950).

(*i*) *Rahar* :—The previous observation that the rahar plant does not bear nodules after eight to twelve weeks' growth was confirmed. The mechanism of fixation of nitrogen by rahar plant is under study.

Manuring of rahar with ammonium sulphate (40 lbs N) gave the besr yields followed by N+P (40 lbs N+120 lbs. P_2O_5) which is followed by P at 120 lbs P_2O. K at 60 lbs K_2O gave yields less than the control. When K is added with N+P the yields were less than those due to N+P.

(*ii*) *Gram* :—Gram grown in red soil at Coimbatore bore no nodules but when inoculated with black soil of the same locality, produced nodules and gave increased yields.

Examination of nodule formation in different varieties of gram at Kanpur and Shahjahanpur in U.P. and Ferozepur, Rohtak and Karnal in Punjab (I) showed wide variations which suggest that the yields of the crop are likely to be increased by inoculation.

BIOCHEMISTRY

1. *Chemical composition and nutritive value of wheat* :—(N. B. Das and M. L. Mathur, 1949).

Wheat grown with different manurial trearments in the Permanent Manurial Experiments at Pusa was analysed for different constituents. The major constituents of the grains do not differ significantly while their riboflavin content has been found to vary to some extent. Neither riboflavin nor nicotinic acid content of the grains correlated with their protein content.

Different varieties of wheat were analysed for their protein and vitamin B_2 contents. Both these constituents vary considerably from variety to variety.

2. *Diastatic activity of different varieties of wheat* :—(N. B. Das and R. M. Banerjee, 1950).

Different varieties of wheat were examined for their diastatic activity and the values were correlated with their protein content. The diastatic activity varied considerably from variety to variety and showed no correlationship with protein content of the grains.

3. *Essential amino acid composition of food and feeding stuff* :—(N. B. Das, 1950).

Microbiological and paper chromatographic methods were developed for estimating amino acids. Samples of wheat, maize, groundnut cake, grasses and legumes were analysed for tryptophane and methionine.

4. *Mechanism of nitrification in the soil* :—(P. C. Thakur, 1950).

The role of clays in nitrification is being studied. Montmorillonite absorbed the nitrite forming organisms quantitatively.

5. *Biochemical studies on tomatoes* :—(M. L. Mathur, 1947).

Thirty varieties were examined. Some of the hybrids were found to be richer in Vitamin C than the cultivated varieties.

6. *Utilization of Mango-seed Kernels* :—(N. B. Das and R. M. Banerjee, 1951).

Mango seed kernel is a rich source of carbohydrate, fat and minerals. In portein content it compares favourably with rice. It does not vary considerably in chemical composition from variety to variety. Certain simple methods for processing mango seed kernel flour, free from the astringent taste have been developed.

Methods for the preparation of starch which is present in mango seed kernel to the extent of 50-60 percent have been developed. The white starch, thus prepared, is free from tannin and is 5-25 microns in size.

7. *Chromatographic separation of carotenes from plant materials* :—(T. D. Biswas and N. B. Das, 1951).

Different adsorbents were tried for chromatography. Dicalcium phosphate, bone meal, alumina and magnesia have been found to be suitable for separating different isomers of carotene.

PHYSICS

1. *Quantitative estimation of nicotine by absorption spectographic method* :—(C. Dakshinamurthy and B. Ramamurthy, 1950).

Nicotine is characterised by a moderately strong absorption band at 2600 A°. In this region Beer's Law was found to hold good for concentration of nicotine varying from 1 to 30 p.p.m. in dilute HCl. To test the effect of the concentration of HCl on the extinction co-efficient experiments were conducted using from 0·0125 to 0·2 normality of HCl. It was found that the acidity had no effect on the extinction co-efficient.

Nicotine content in tobacco extracted by semi-micromethod in the Section of Organic Chemistry was examined by the spectrographic method. The results agreed with the values obtained by the standard A.O.A.C. method for the same samples.

2. *Quantitative estimation of Vitamin A by the absorption spectropgraphic technique* :—(C. Dakshinamurthy and B. Ramamurthi, 1951).

The procedure has been standardised and is being used as a routine method.

3. *Quantatitive estimation of carotene by the absorption specrographic technique* :—(T. D. Biswas and C. Dakshinamurthy, 1951).

Carotene is being separated by chromatographic technique in the Biochemistry Section and its absorption spectrum is being examined for its purity.

PROGRAM OF WORK FOR 1951-52.

I. SOIL CHEMISTRY

(*a*) *Agricultural Chemistry* :

1. Effect of low doses of phosphate on berseem.
2. Comparative value of different *rabi* legumes.
3. Utilization of wild leguminous plants for green manuring.
4. Conservation and utilisation of human urine as manure.
5. Effect of soaking seeds in nutrient solutions.
6. Fertilizer value of dicalcium phosphate.
7. Cation-anion relationships in plant and seeds.

(*b*) *Soil Chemistry* :

8. Investigations on soil organic matter.
9. Studies on the fixation of potash in soils.
10. Studies on the nature of clay in saline soils.
11. Studies on the use of 8-hydroxyquinoline for direct determination of Al, Fe, Ca, and Mg.
12. Investigations on the manurial value of tank silts.
13. Development of rapid methods for water and soil analysis in advisory work.

(c) *Soil Fertility*:

14. Building up of soil fertility by phosphatic fertilisation of legumes.
15. Building up of soil fertility by crop rotation.
16. Causative factors of improved soil fertility after the growth of berseem.
17. Influence of the chemical composition of root systems of crops on nitrate developments in soils.
18. Experiments on compost making.
19. Chemical control of leaf curl disease of tobacco.

(d) *Micronutrient*:

20. Studies on micronutrient status of Indian soils.
21. Investigation on the Top yellowing of gram.
22. Micronutrients in grasses, forages and concentrates.
23. Deficiency diseases caused by micronutrients in some Indian crops.
24. Mineral deficiencies in citrus. (I.C.A.R. Scheme).

II. SOIL PHYSICS

25. Studies on soil moisture and soil aggregates.

III. PHYSICAL CHEMISTRY

26. Electrochemical properties of hydrogen clays from typical Indian soils on profile basis.
27. Electrochemical properties of pure clay minerals singly and in mixture.
28. Base exchange studies in clays.

IV. SOIL SURVEY

29. Soil and land utilisation survey of Delhi villages.
30. Soil Survey of Rann of Cutch.
31. Reclamation of saline and alkaline soils.
32. Study of chemical and physical properties of soil under Tractor Cultivation at Bhopal (in collaboration with the Central Tractor Organisation).
33. Mineralogical studies of Indian soils.

V. ORGANIC CHEMISTRY

34. Development of a rapid method for the determination of unsaturation of oils.
35. Investigation of suitable methods for prevention of adultration of milk ghee with hydrogenated oils.
36. Development of semi-commercial method for manufacture of nicotine sulphate from tobacco and tobacco wastes.
37. Studies on synthetic insecticides and fungicides.
38. Preparation of suitable formulations of insecticides for agricultural purposes.

VI. SOIL MICROBIOLOGY

39. Study of *Azotobacter* species of Indian soils.
40. Inoculation of some *rabi* cereals with *Azotobacter* under different conditions with a view to increase crop production.
41. Manurial value of sannhemp seeds with special reference to nitrogen status of the soil and its economic value.
42. Studies on Nitrogen Fixation.
43. Study of part played by micro-organism of F.Y. Manure in increasing crop yields.

VII. BIOCHEMISTRY

44. Chemical composition and nutritive value of different varieties of wheat.
45. Biochemistry of nitrification in the soil.
46. Estimation of amino acids in proteins and their digestibility in food and feeding stuff.
47. Nutritive value of different varieties of tomato and sweet potato.
48. Estimation of different isomers of carotene in green leaves and vegetables at different stages of growth.
49. Utilisation of mango-seed kernel.

VIII. PHYSICS

50. Quantitative estimation of trace elements Mn, Cu, Co, Mo and Cr by Cathode Layer arc technique (using the step sector).
51. Quantitative estimation of carotene in foods and fodders by spectrophotometric method.
52. Quantitative estimation of chlorophyl by spectrophotometric method.

REPORT OF THE DIVISION OF ENTOMOLOGY FOR THE YEAR 1950-51.

(*Dr. E. S. Narayanan*)

SECTION OF PARASITOLOGY

(*A*) *Fundamental studies in Insect Parasitism* :

(*i*) *Mechanism of oviposition in Stenobracon deesae* (*Cam*). The structure of the female genitalia and the accessory organs, and the mechanism of oviposition in *Stenobracon deesae*, a potential parasite of the sugarcane and maize borers, were investigated in detail. A valve which controls the flow of poison from the poison receptacle, while stinging, has been discovered for the first time. The musculature that aids in the process of oviposition was also studied. It was found that the pedicellate egg in *Stenobracon* travels down the long ovipositor through the poison canal, in a highly compressed state, and during oviposition, the body of the egg is not visible outside until it reaches the tip of the ovipositor. This observation differs from the general view held by many workers that the main body of the egg remains outside during oviposition and that only the stalk of the egg is held in the ovipositor canal. A paper on the mechanism of oviposition has been written up for publication.

(*ii*) *An unrecorded Pteromalid hyperparasite on Stenobracon deesae* (*Cam.*)—In the course of studies on *Stenobracon deesae*, a pteromalid hyperparasite has been found parasitising the pupae of *Stenobracon deesae* in Delhi. So far there is no published record of any hyperparasite on this potential parasite. The discovery of a hyperparasite on *Stenobracon* will be a warning to other workers in India to examine their material carefully before introduction and establishment of parasites in the field. A note on this hyperparasite has been sent to *Current Science* for publication.

(*iii*) *The anatomy & histology of the reproductive organs in Bracon gelechiae Asm.*—The structure and function of the various organs connected with the reproduction in male and female *Bracon*

gelechiae, have been studied in detail. The structures show interesting and new features. A paper on the results obtained so far is being written up for publication.

(*iv*) *Superparasitism in Trichogramma evanescens minutum Riley.*—Observations recorded so far show that there is a progressive decrease in the percentage of superparasitism with the increase in the host-density ranging from 10 to 100 eggs. A maximum of 20 per cent. superparasitism was observed when 10 *Corcyra* eggs were exposed to one pair of parasites, while a maximum of only 1-2 per cent. superparasitism was observed when the host-eggs were increased to 90 and 100. In cases where superparasitism occurred, not more than two parasites developed from a single host-egg, and they were in almost all cases one pair each. The parasite is capable of laying two eggs in a single oviposition though this phenomenon is very rare. The tendency of superparasitism is probably due to failure of restraint on the part of the female parasites. Further the parasite is unable to discriminate between the healthy unparasitized host-eggs from those parasitized by another female.

(*v*) *Studies on the fecundity and longevity of Bracon gelechiae Ashm.*—It was verified by careful dissection that the number of ovarioles and their relative development were important factors that governed the fecundity of the parasite. It was also experimentally proved that the condition and availability of food material in the host influenced the growth and formation of the ovarioles of parasites bred on the same. This parasite readily parasitized the larvae of *Heliothis armigera* Fabr. and in the progeny of parasites produced there was a preponderance of females. In the case of the wax moth, *Galleria mellonella* Linn., the average egg-laying capacity was 110 eggs per female, whereas in the case of *Apis indica* Fabr. it was 86 eggs per female. The corresponding average longevity of the parasites reared from these two hosts were 16 and 20 days and 18 and 22 days in the males and females respectively.

(*B*) *Biological control of insect pests* :

Mass breeding of parasites.—(*i*) *Bracon gelechiae Ashm.*—This parasite was bred exclusively on the laboratory host, *Corcyra cephalonica* St. at the rate of about 6000 parasites per month. (*ii*) *Bracon* (*Microbracon*) *chilonis* Vier. This parasite was found to attack the larvae of the maize stem borer, *Chilo zonellus* Swinh. The breeding of this parasite on the larvae of *Corcyra* was in progress.

Insect Vectors of virus diseases.—

Biology and life-history of Trialeurodes ricini M., the white-fly vector of leaf-curl on castor.—Castor is a very important oil seed crop whose seeds are widely used for extracting oil mainly for medicinal and lubricating purposes. In nature, castor plants often exhibit serious curling disease of the foliage. Out of two common varieties of castor, the green variety is easily attacked by the white-fly in the field as well as in the rearing cages, while the red variety appears to be resistant. Similarly green variety exhibits typical symptoms of virus infection, the red variety being resistant to the disease. The systemic nature of the disease was indicated by the development of symptoms on young foliage and shoots after the main diseased leaves had been removed. Since the white fly *T. ricini M.* transmitted the disease from diseased to healthy castor plants, studies on the biology, life-history, etc., of this species were taken up in detail with a view to apply effective control against the pest and thus reduce the damage to the minimum. A single female white-fly could lay upto a maximum of 92 eggs in the middle of the basel region between major veins on the undersides of leaves. Profuse egg-laying was noticed in the middle of July and a large number of parasites, *Eretmoceros* sp. emerged from the puparia during July- October. They lived on honey dew secreted by the immature stages of the white fly. In the rearing cages, and the field, eggs and nymphs were attacked by a mite *Tetranychus* sp. to the extent of 5-7·5 per cent during December-January. Freshly laid eggs are creamy white and the immature stages on hatching are also confined to this area which develops irregular depressions followed by curling up of the lamina and being devoid of chlorophyll, the epidermal layers eventually become perforated.

The incubation period of the egg varies between 5-15 days, nymphal period 10-16 days, pupal period 4-6 days and life cycle 19-37 days during the year. The shortest incubation period was 5 days in May, longest was 15 days in January, shortest nymphal period was 10 days in May, longest was 16 days in March; shortest pupal period was 4 days in April-May, longest was 6 days in March; and life-cycle was 19 days in May and longest was 37 days in January. There were 10 generations of the white fly during the year.

Studies on stored grain pests and their control.—

Biology of Tenebroides mauritanicus *Linn.*—The beetles mate within an hour after emergence. There are four instars of the grub, the first one measuring 0·60 mm. × 0·25 mm., the second 0·5 mm. × 0·26 mm., the third 2·5 mm. × 0·95 mm. and the fourth 4·0 mm. × 1·5 mm. The grub of the first instar has a characteristic U-shaped chitinous plate of pro-thorax, and this is lost in the second instar. In the fourth, the body wall of the grub is raised into segments and wavy protrusions carrying a few hairs. There is a distinct pre-pupal stage in which the grub becomes straightened, with head resembling that of full-grown grub. The pupa is pale white and measures 3·5 mm. × 1·5 mm. The beetles hibernate as grubs for 5-7 weeks within the grains during December-January. They are bisexual in sex ratio and pass through 10 generations in a year.

Effects of some insecticides on the population of potato aphids.—

A systematic spraying and dusting experiment was carried out to study the effect of DDT-sulphur, BHC, Pyrethrum powder-sulphur, tobacco decoction and fish oil rosin soap on the population of aphids on potato crop. *Myzus persicae* Sulz. and *Aphis rhamni* Fonse. were the only aphids found on potato. The experimental potato field was divided into 18 equal blocks, each 25' × 25', having 6 rows of 6 plants. These plots were randomly divided in such a way that on each occasion each treatment could be replicated 3 times. During the season the insecticides were applied on 3 different occasions.

The effect of the insecticides was assessed on the basis of aphid population per 20 potato leaves (10 leaves each 20 apical selected at random from 10 plants in each plot). Aphid population counts were made 24 hours preceding and 24 hours following each application. The percentage of aphids controlled obtained with each insecticide as a result of 3 applications is given in the Table below :—

Treatment	*M. persicae* % control	*A. rhamni* % control
1. Gammexane 1 per cent containing 0·6 per cent Y isomer and Silex 99 per cent	91·87	71·08
2. BHC 4 per cent, Y=6 per cent & sulphur dust 50 per cent	84·42	50·17
3. Pyrethrum powder Pyrethrins 10·42 per cent & Pyrethrin II 0·819 per cent & sulphur dust 50 : 50	36·73	37·35
4. Tobacco decoction containing 0·1 per cent nicotine	62·90	90·07
5. Fish oil rosin soap 3 oz. in 1 gallon water	8·92	54·67

The above table shows that gammexane gave the highest control (91·87%) of *M. persicae*, while BHC sulphur was the next best as it gave upto 84·42 per cent. Tobacco decoction on the other hand proved to be the best in the case of *A. rhamni* where it gave 90·07 per cent, though it was not found to be the best in the case of *M. persicae* where it gave only 62·90 per cent. Gammexane and fish oil soap (the latter at the rate of 3lbs. in 1 gallon water) were the next best in controlling the first named species. Gammexane and fish oil soap gave 71·08 per cent and 54·67 per cent control of *A. rhamni* and were thus second and third respectively in the ordered merit. While pyrethrum powder-sulphur was the least as it gave only 8·92 per cent. control of *M. persicae*.

Studies on factors governing development of winged aphids, Rhopalosiphum pseudobrassicae (Davis).—

To study the effect of crowding of adult forms of *Rhopalosiphum pseudobrassicae* (Davis) on the development of winged progeny, rooted plants of four height classes (viz., 1, 2, 3, and 4 inches) were

taken on which four different populations during 1950 experiments and five different populations during 1951 experiments of alate-aphids (*viz.*, 5, 10, 15, 20 and 30 individuals) were released and allowed to reproduce for 48 hours. The alate-progeny of 5 to 20 alate-parents obtained on plants of one to four inches height does not differ significantly from control. It seems in this case that there is not sufficient crowding of the alate-parents on the plants which could significantly induce the development of alate-off spring. It is also found that the highest number of alate-aphids, *viz.*, 30 produce significantly more alate offspring than 5 to 20 alate-parents and the control when the plants employed are of one and two inches size.

To study the effect of starvation of alate-parent aphids on the development of alate-offspring, the former were starved for 6, 12, 24 and 36 hours prior to their release on mustard plants of six inches height. The experiments conducted during 1950 have shown that the alate-offsprings of the alate-parents starved for six hours obtained during 49 to 96 hours after the end of starvation differ significantly from those produced during 97 to 144 hours after the expiry of starvation period (at 5 per cent. level) and the control (at 1 per cent. level). The alate-parents starved for 12 to 36 hours do not produce significantly more alate-young ones during 1 to 144 hours after the cessation of starvation. A repitition of starvation experiments during 1951 has indicated that regarding the effect of six hours starvation of winged-parents on the production of winged-progeny the results are similar to those obtained during 1950. Moreover during 1951 it has been further observed that the starvation for six hours is also found to produce significantly more (at 5 per cent. level) alate-offspring during 97 to 144 hours after the end of starvation. It is also evident from these observations that the alate-progeny produced during 1 to 48 hours after the expiry of starvation period is significantly superior (at 1 per cent level) to alate-parents starved for 12 hours and significantly better (at 5 per cent. level) than that of alate-parents starved for 24 hours and the control.

To study the effect of atmospheric temperature and humidity on alate-aphids on the development of alate-offspring, different numbers of fresh alate-parents were allowed during 1951 to reproduce for 48 hours on mustard plants of six inches height. A record of temeperature and humidity for the entire period was maintained. It is found that at average temperature of 52·8°F. to 61·2°F. combined with average relative humidity of 69·3 per cent. to 89·9 per cent., the offsprings are entirely apterous or consist of 1·9 to 5·3 per cent. alate-individuals. At 59·1°F. to 68·6°F. with 61·1 per cent. to 71·7 per cent. humidity the number of alate-progeny varies from 10 per cent. to 17·7 per cent. At 62·9°F. with 69·8 per cent. to 71·3 per cent. humidity, the number of winged off-spring rises from 25·3 per cent. to 32·3 per cent.

Conclusion.—The data obtained show that mal-nutrition due to crowding and starvation and a combination of temperature and humidity producing drier atmospheric conditions during the course of developments of these insects appear to induce to some extent the formation of wings in the progeny of alate-parent aphids.

Physiology of pupation in fruit flies.—

The pupation in *Didacus ciliatus* (Loew.) has been found to be controlled by a hormone and the ' critical period ' when it is discharged in haemolymph of maggots is about 20 hours before pupation at 25°C. (77°F.) with extremes of 11 and 30 hours. The ligature and injection experiments combined with microscopical studies have conclusively proved that Wiesmann's Ring-gland secretes the pupation hormone in this insect. It has been noticed that injections of fluid containing this hormone cause the pupation of 3rd stage maggots only and not the 2nd stage maggots. This indicates that this hormone induces pupation in those maggots which have developed to a stage which is conducive to its action.

The body fluid of pupating maggots of *D. ciliatus* or *Chaetodacus cucurbitae* (Cog.) on *Musca nebulo* Fab. (all Diptera) or that of caterpillars of *Corcyra cephalonica* St. (Lepidoptera) or that of grubs of *Aulacophora foveicollis* Lucas (Coleoptera) when injected twice at twelve hours interval

in maggots of *D. ciliatus* not ready for pupation, has induced the latter to produce within 24 hours after first injection; whereas the control maggots, which have not received any injection, pupate much later, *i.e.*, 48-72 or 48-96 hours. Thus it is definitely proved that the pupation hormone is not peculiar to the species.

The Wiesmann's Ring Gland in pupating maggots of 3rd stage consists of large cells with ill-defined boundries containing big nuclei and numerous vacuoles. The big cells appear to secrete pupation hormone. A patch of undifferentiated small cells remain at its interior end, which become much larger in pupal stage. It is probable that these cells might form the corpus allatum while the large cells of the main body of the gland as corpus cardiacum of the adult fly.

Apiculture.—

Studies on the possibilites of bee-keeping in Delhi were carried out in Delhi. The honey bees Apis indica Fabr. were found to collect nectar from *Murraya exotica* (Rutaceae). *Eugenia jambolana* (Myrtaceae), *Sesamum indica* (Labiatae), *Ricinus communis* (*Euphorbiaceae*), *Musa sapientum* (Musaceae), *Brassica campestris* (Cruciferae), *Melia azederachta*, *Pungamia glabra* (Leguminosae); pollen from *Zea mays* (Graminaceae), *Impatiens balsamina* (Geraniaceae), *Solanum melongena* (Solanaecae) *Crotalaria juncea* (Leguminosae), *Cucurbita moschata* (Cucurbitaceae), garden plants, *viz.*, *Helianthus annuces*, *Chryspanthemum*, *Zinnia elegans* (Compositae), *Petunia axillaris*, *Antirrhinum majus* (Scrophulariineae); and pollen and nectar from mango, citrus and *Citharexylon subserratum* (Verbenaceae), *Murraya exotica* (Rutaceae), *Lagaestromia indica* (Lythraceae), *Cucurbita maxima* (Cucurbitaceae) and *Pungamia pinnata* (Leguminosae).

SECTION OF SYSTEMATIC ENTOMOLOGY

(*i*) *Lariidae* (= *Bruchidae*): —Studies on the morphology and external genitalia of this family of pulse beetles of India and Ceylon were completed and a comprehensive paper on the subject has been accepted for publication.

(*ii*) *Scelionidae*: Studies on the systematics of parasitic Scelionidae of India and the Orient which constitute severa egg-parasites of Acrididae revealed an important species, *Scelio oviphaga* sp. nov. parasitising the eggs of *Hieroglyphus nigrorepletus* Bol. (phadka) collected from Ajmer. The morphology of the female parasite has been studied in detail and a structure (hitherto undescribed) associated with the ovipositor has been traced for the first time. A key to the well known species of *Scelio* (of the Oriental region) which parasitise the eggs of Orthopthra has been prepared.

(*iii*) *Aerial insect fauna*: To collect and identify the different species of insects in flight with particular reference to lower altitudes from the ground level, season, meteorological factors, etc., muslin bag-nets were fixed at different heights on buildings in the Institute area ranging from 30 feet to 60 feet and the insects captured were collected daily from the nets, examined and recorded. At 30 feet height in July the common species captured was *Myllocerus maculosus* Fabr., at 40 feet in August-September, *Aulacophora foveicollis* (Lucas) and *Aspongopus janus* Fabr. *Myzus persicae SULZ.* and *Bagrada cruciferarum* Kirk. The first named species is a pest feeding on the leaves of fruit trees; the next two are important pests on cucurbits and the remaining two on potato and brassica. In October *M. persicae* Sulz. and *Aphis gossypii* Glover were collected; they are important pests on potato, cucurbits, tomato, tobacco, etc. In January at 60 feet *M. persicae* Sulz., *A. gossypii* Glover, *Lygaeus pandurus* Leth and *Idiocerus clypealis* Leth were collected. *L. pandurus* Leth is a pest on linseed, cowpea, potato etc., and *I. clypealis* Leth on mango blossoms. In February at 40-60 feet *Rhopalosiphum pseudobrassicae* Fabr., *Macrosiphum granarium* Kirby and *Aphis laburni* Kalt were collected. In March at 60 feet *Brumus suturalis* Fabr., and *Scymnus nuvilus* Muls, were collected and both are predators on aphids, white-flies, coccids, etc. In April-May at 60 feet *B. cruciferarum* Kirk., *Empharina citri* Kuw. and *Syrphus balteatus* DeGeer were collected. *D. citri* Kuw. is a pest on citrus and the maggots of *S. balteatus DeGeer* are predators on *R. pseudobrassicae* Fabr.

SECTION OF ECOLOGY AND TOXICOLOGY

(1) *Epidemiology of cotton bollworm.*—Besides continuing the routine of collecting the usual regular bioclimatic data, those collected during 1942-1948 have been under detailed study of the Statistician's staff and this Division continued efforts to interpret and analyse them from the entomological point of view. No definite conclusion can be reported so far.

(2) *Ecological studies on Trichogramma for constructing Biometer.*—Seven factors, *viz.*, (*i*) blackening period of parasitized eggs, (*ii*) emergence period, (*iii*) longevity without food, (*iv*) life period, (*v*) per cent. parasitism, (*vi*) per cent. emergence and (*vii*) sex ratio, in the biology of the *Trichogramma* parasites were studied under 75 per cent. and 35 per cent. relative humidities and five different temperatures, *viz.*, 11°C., 18°C., 29°C., 30°C., and 35°C. It was found that lower relative humidity (35 per cent.) at higher temperature (35°C) affects the parasite adversely.

(3) *Ecological studies on Hieroglyphus nigrorepletus.*—The egg masses of *Hieroglyphus nigrorepletus* were obtained from Ajmer for studying the following three aspects : (*i*) *effect of watering on viability of egg masses* : It was found that eggs did not hatch in pots watered daily but hatched in those where watering was done on alternate days or once in two days. (*ii*) *food preference* : The nymphs were given the leaves of four plants, *viz.*, guar, cotton, jowar and maize. The hoppers were found to feed only on the last two while those offered guar and cotton died of starvation. (*iii*) *effect of humidity on nymphal stages* : All nymphs kept at 30 per cent. relative humidity died without completing their nymphal period. At 50 per cent. relative humidity the nymphal period varied from 2 months 7 days to 2 months 13 days, and at 75 per cent. relative humidity nymphal period varied from 2 months to 2 months 3 days. The experiment is in progress.

(4) *Insect Epicuticle in relation to the action of insecticide.*—The following results were obtained : (*a*) The outermost epicuticular layer in the four species of Hemiptera, *Dysdercus cingulatus*, *Harpactor* sp., *Bagrada picta* and *Aphis* sp. and one species of Coleoptera, *viz.*, *Bruchus analis* (adults) is just a wax layer whereas in the case of the larvae of two species of Lepidoptera, *viz.*, *Corcyra cephalonica* and *Euproctis lunata* and the grubs of one species of *Coleoptera*, *viz.*, *Trogoderma granaria* the wax layer is covered by a harder cement layer. (*b*) The lipoid extract from the exuviae of *Trogoderma* larvae is a hard wax, that from *Harpactor* is a soft wax and that from *Euproctis* is greasy. (*c*) A very simple technique was evolved for studying the solubility of DDT in cuticular waxes of insects. It was found that DDT crystals dissolve far more rapidly in the films (on glass slides) made from the soft wax of *Harpactor* of *grease* of *Euproctis* than in the films made from the hard wax of *Trogoderma.* (*d*) At higher temperatures DDT crystals dissolve in these wax films more rapidly. (*e*) Susceptibility tests carried out with the different inert dusts, *viz.*, quartz, magnesite, and rock phosphate gave the following order of susceptibility :—*Aphis*=*Bagrada*<*Bruchus*<*Euproctis*<*Corcyra*< *Trogoderma.* The Tables I, II and III give the results obtained.

Also experiments on the effect of dusts on the loss of weight by insects showed that insects with higher susceptibility to dusts, also showed higher loss of water from their bodies after treatment with these dusts.

(5) *Bioassay of stomach poison*—Studies on DDT as stomach poison against larvae of *Euproctis lunata* (*Lepidoptera*) have indicated the following tentative conclusions :—

(*a*) Starvation for 24 to 48 hours makes these larvae somewhat lethargic resulting in a reduction rather than increase in the amount of both poisoned and unpoisoned food taken subsequently. As a result of lesser amount of poison ingested, the mortality is also comparatively lower in starved larvae indicating apprently an increase in resistence due to starvation. This apparant conclusion is, however, disproved on closer analysis of data on the basis of the amount of poison ingested per gram body weight of the larvae. Actually the resistence appears to decrease slightly due to increased period of starvation (*vide* Table IV).

(*b*) The quantity of poisoned leaf-sandwich ingested per larva decreases with the increase in the amount of poison per unit area of the sandwich ; all the same, the amount of poison ingested and consequently the mortality increases.

(*c*) The same amount of poison ingested in one instalment was more effective than if it was ingested in several small instalments.

(*d*) The amount of poisoned sandwich eaten per larva increases with body weight, but the amount ingested per unit of body weight varies within a narrow range. Resistence seems to increase with body weight (*vide* Table V).

Besides these observations of fundamental nature, the efficacy of DDT and gamma BHC as stomach poison was also studied against five *Lepidopterous* larvae *viz.*, *Euproctis lunata*, *Plusia orichalcea*, *Laphygma exigua*, *Prodenia litura* and *Utetheisa pulchella* and also nymphs of *Poecilocerus picta* (Orthoptera).

(6) *Effect of temperature on the susceptibility of mosquito larvae* (*Culex fati gans*) *to DDT suspensions*—

As the result of a series of explorative experiments on temperature coefficient of DDT action, the following observations were made :—

(*a*) When the pre-treatment temperature was low (12 ± 2°C.) there was a clear positive temperature coefficient of DDT action at all concentrations of DDT in the suspension.

(*b*) When the pre-treatment temperature was 30°C. or 20 ± 2°C. there was a negative temperature coefficient so far as temperatures upto 27°C. were concerned, but this negative trend was often disturbed due to higher mortality at 30°C. than at 27°C.

(*c*) When the pre-treatment temperature was 27°C. (temperature at which the larvae were bred), the temperature coefficient was least predictable.

Possible explanations of these observations have been discussed in the light of the generalisations put forward earlier (Pradhan, 1949). The results are given in Tables VI, VII & VIII).

7. *Mode of action of insecticidal sprays.*—Studies on the following two new aspects of the mode of action of insecticidal sprays were completed with three species of insects, *viz.*, *T. castaneum*, *E. lunata* and *C. cephalonica*.

(*a*) Number of droplets of DDT solution in benzene contained in an emulsion versus concentration of DDT in those droplets (*b*) Toxicity of DDT to insect eggs. Results obtained are given in Table IX to XII.

From the Tables IX and X will be seen that while an emulsion containing fewer droplets of higher DDT concentration was more toxic to adults of *T. castaneum*, it was less toxic to larvae of *E. lunata*. It was found that when the amount of DDT used in sprays was constant, both the concentration of DDT in the droplets as well as the number of droplets present in the emulsion exerted their respective effects, but the ultimate effect felt was that of one which was effective of the two. It is clear from the results in the Tables XI and XII that DDT emulsion (benzene in water) does not appear to affect the development of the embryos in any way but, when in sufficient concentration is observed to be effective at the time of eclosion in preventing the hatching of the eggs. An attempt to explore the possible manner in which the embryos of *E. lunata* is protected from the toxic action of DDT gave some evidence to indicate that the vitelline membrane might be acting as the barrier to the passage of DDT upto the developing embryos.

8. *Effect of fumigation on germination of seed grains.*—Two fumigants, *viz.*, chlorosol (ethylene dichloride and carbon tetrachloride mixture in 3 : 1 ratio) and acrylon (acrylonitrile and carbon

etrachloride mixture 50 : 50) were tried for their effect on germination of maize seeds. The results btained with acrylon alone are given here as the results with chlorosol were not conclusive. It is lear from the results given in Table XIII that wheat grains having 13 per cent. of water or more- ppear to be adversely attacked in the beginning by Acrylon fumigation but slowly the effect dis- ppears. The adverse effect of saturated vapour appears to be permanent.

PROGRAMME OF RESEARCH WORK OF THE ENTOMOLOGY DIVISION FOR THE YEAR 1951-1952.

1. INSECT PARASITOLOGY

a) Fundamental studies in insect parasitism :

(*i*) Effect of low temperature on the viability, longevity, fecundity and sex-ratio of *Microbracon gelechiae*, larval parasite of the potato tuber moth, *Gnorimoschema operculella*.

(*ii*) Nutritional studies on the laboratory host, *Corcyra cephalonic*. Relative nutritive value of different kinds of food.

(*iii*) Influence of hosts upon their insect parasites—studies on the relationship between host physiology and the sex of the parasite.

(*iv*) Studies on the host-parasite relationships of *Lestodrinus pyrillae*, a parasite of the sugarcane leaf hopper, *Pyrilla* spp.

b) Biological control :

(*i*) Mass breeding of *Bracon gelechiae*, a parasite of the potato tuber moth.

(*ii*) Control of potato tuber moth, *Gnorimoschema operculella* by *Bracon gelechiae*.

(*iii*) Control of the maize borer, *Chilo zonellus* by the combined use of the egg and larval parasites

2. INSECT TAXONOMY

a) Cataloguing of Indian insects :—(*i*) Coccinellidae (Coleoptera), (*ii*) Pyralidae (Lepidoptera), (*iii*) Tachinidae & Asilidae (Diptera), (*iv*) Eumenidae (Hymenoptera).

b) Studies on the genitalia of Scolitidae and Anobidae from the systematic point of view.

c) Studies on the genitalia of Hymenoptera from the point of view of systematics.

d) Study of genitalia of Thysanoptera from the systematic point of view.

e) Morphology of certain structures of insect pests with special reference to their vulnerability.

3. INSECT PHYSIOLOGY

Physiological studies :

(*a*) Factors controlling pupation of insects.

(*b*) Factors responsible for the production of winged insects.

(*c*) Effect of nutrition on the life-history of *Rhizopertha dominica*.

4. INSECT ECOLOGY & TOXICOLOGY

a) Epidemiology of cotton bollworms.

b) Ecological studies on *Hieroglyphus nigrorepletus*.

c) Loss of water from insect's body—water balance in insects.

d) Aerial insect fauna.

(*e*) Bioassay of insecticides.

(*f*) Effect of temperature on insects' susceptibility to fumigants.

(*g*) Effect of temperatures on insects' susceptibility to insecticide dust.

5. INSECT VECTORS OF VIRUS DISEASES

(*i*) Studies on white-flies, jassids, aphids and thrips on castors, bhindi, chilli, tomato, etc.

(*ii*) Transmission experiments with vectors.

6. MISCELLANEOUS AND ROUTINE OBSERVATIONS

(*i*) Studies on stored grain pests and their natural enemies.

(*ii*) Observations on Indian insects of economic importance :

(*a*) Pests of crops at I.A.R.I. and in the neighbouring villages with a view to assist the local cultivators in controlling the pests under the Delhi Intensive Cultivation Scheme.

(*b*) Fruit pests.

(*c*) Insect pests of potatoes.

(*d*) Insect pests of sugarcane and their natural enemies.

(*e*) Predators and parasites.

(*iii*) Studies on immature stages of insects.

TABLE I

Percentage mortality of different insects on quartz dust at 24 hours interval

Insect	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day
Trogoderma	0	0	0	0	0	0	0
Corcyra	0	0	0	0	5	5	
Euproctis	5	50	55	60	70	80	95
Bruchus	35	90	100	100	100	100	100
Bagrada	25	100	100	100	100	100	100
Aphis	35	100	100	100	100	100	100

TABLE II

Percentage mortality of different insects on magnesite dust at 24 hours interval

Insect	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day
Trogoderma	0	2·5	12·5	12·5	12·5	12·5	12·5
Corcyra	0	0	0	15·8	39·5	48·6	61
Euproctis	0	2·5	25·6	47·4	87·6	90	90
Bruchus	37·5	95	100	100	100	100	100
Bagrada	95	100	100	100	100	100	100
Aphis	30	100	100	100	100	100	100

Table III

Percentage mortality of different insects on rock phosphate dust at 24 hours interval

Insect	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day
Trogoderama	0	0	0	0	0	2·5	2·5
Corcyra	0	2·6	15·8	31·6	39·5	47·4	58
Bruchus	20	88	100	100	100	100	100
Bagrada	32·5	90·8	100	100	100	100	100

Table IV

Showing effect of starvation on the feeding of E. lunata *larvae on sandwiches bearing DDT and talc.*

Period of starvation	No. of larvae treated	No. of larvae which ate	Leaf area consumed per larvae average	Average dosage mg./gm.	Percentage kill in 6 days.
DDT 3½ hrs.	8	5	8·2 sq. mm.	·234	100
24 hrs.	8	6	7·7 sq. mm.	·192	100
45 hrs.	8	2	6·5 sq. mm.	·121	50%
Talc 3½ hrs.	2	2	26·5 sq. mm.	2·074	*Nil*
24 hrs.	2	2	22·5 sq. mm.	2·22	*Nil*
45 hrs.	2	1	12 sq. mm.	·975	*Nil*

Table V

Effect of body weight on the amount consumed and susceptibility

Average weight of larvae	No. of larvae treated		Average area of sandwich consumed per larva		Average dosage consumed mg./gm.		Percentage mortality	
	DDT	Talc	DDT	Talc	DDT	Talc	DDT	Talc
(*a*) ·029	13	4	4·46 sq. plani	24·7 sq. plani	·1502	8·24	100	*Nil*
(*b*) ·0427	7	4	7·7	28	·1745	5·1	85·7	*Nil*
(*c*) ·0607	7	4	9·9	27·2	·1578	4·33	71·4	*Nil*
(*d*) ·0732	5	4	10·6	27·5	·1407	3·63	60	*Nil*
(*e*) ·1081	10	4	22·3	27·2	·1996	2·43	60	*Nil*

Table VI

Percentage mortality in mosquito larvae pretreated at 12 ± 2°C and treated at different temperatures in three different concentrations of DDT suspension

Observation days	1 in 10 m.			1 in 100 m.			1 in 1000 m.			Control		
	12±2°C	20±2°C	30°C	12±2°C	20±2°C	30°C	12±2°C	20±2°C	30°C	12±2°C	20±2°C	30°C
1st	16	24	40	8	12	20	4	4	8	4	4	8
2nd	24	32	72	12	20	52	4	4	28	4	4	12
3rd	44	52	100	16	32	88	12	20	64	8	12	..
4th	52	76	100	24	52	100	12	24	100	8	12	..
5th	56	80	100	28	64	100	20	28	100	8	12	..
6th	56	100	100	36	92	100	24	76	100	8	28	..
7th	68	100	100	44	100	100	32	92	100	20	28	..
8th	72	100	100	48	100	100	44	100	100	36	52	..
9th	84	100	100	84	100	100	84	100	100	52	..	..
10th	100	100	100	100	100	100	96	100	100	72	..	..

Table VII

Percentage mortality in mosquito larvae pretreated at 30°C and treated at different temperatures in three different concentrations of DDT suspensien

Observation days	1 in 10 m.			1 in 100 m.			1 in 1000 m.			Control		
	12±2°C	20±2°C	30°C	12±2°C	20±2°C	30°C	12±2°C	20±2°C	30°C	12±2°C	20±2°C	30°C
1st	100	56	20	72	16	20	44	8	12	36	4	4
2nd	100	76	72	92	36	60	88	32	60	64	28	52
3rd	100	100	100	100	76	92	96	60	80	77	52	72
4th	100	100	100	100	100	100	100	100	100	80	68	84

Table VIII

Percentage mortality in mosquito larvae (pretreated at 27°C) due to DDT concentration of 1 part in 500 million parts of tap water at four temperatures

Observation days	DDT in 500 m.				Control			
	10°C	25°C	27°C	30°C	10°C	25°C	27°C	30°C
1st	100	7	10	0	43·3	0	3	0
2nd	100	25	53	17	60	10	27	17
3rd	..	..	..	..	..	..	..	..
4th	100	70	77	52	..	27	60	40
5th	100	93·4	83	80	..	43	60	50
6th	100	93·4	96·6	87	..	57	60	67

TABLE IX

Effect of concentration on the toxicity of emulsions to T. castaneum *adults*

Emulsion	Strength of DDT % in emulsion	Percentage mortality after intervals			
		24 hrs.	48 hrs.	72 hrs.	
				adjusted	
A. with 2·5% benzene content	0·25	72	94	100	100
	0·125	44	78	86	85·4
	0·0625	16	50	64	62·5
	0·03125	4	30	44	41·7
	0·0156	0	8	12	8·1
Medium A with 2·5% benzene content	..	0	2	6	2·1
B. with 5% benzene content	0·25	54	90	98	98·0
	0·125	38	72	84	83·3
	0·0625	8	40	60	58·3
	0·03125	6	22	42	39·6
	0·156	2	8	14	10·4
Medium B. with 5% benzene content	..	0	0	2	0
No treatment (Control)	..	0	2	4	0

TABLE X

Effect of concentration on toxicity of DDT emulsions to E. lunata *larvae*

A. with 2·5% benzene content	0·5	62·2	86·7	91·1
	0·25	51·1	75·6	84·4
	0·625	37·8	66·7	82·2
	0·0625	28·9	108·9	55·6
Medium A. benzene content	..	0	0	0
B. with 10% benzene content	0·5	77·3	88·9	97·8
	0·25	60·0	82·2	84·4
	0·625	51·1	75·6	80·0
	0·0625	28·9	46·7	57·3
Medium B.	..	0	0	0
No treatment	..	0	0	0

TABLE XI

Toxicity of DDT emulsion to eggs of E. lunata

Spray treatment	No. of eggs used	Hatches on different days						Total hatch upto 11th day	9th day dissection			11th day dissection			
		6th	7th	8th	9th	10th	11th		No. of dissection	No. of dead	No. of alive	No. of dissection	No. of dead	No. of alive	No. failed to develop
·25% DDT ..	100	0	0	0	0	0	0	0	10	1	9	90	80	7	3
·5% DDT	100	0	0	0	0	0	0	0	10	1	9	90	77	9	4
% DDT	100	0	0	0	0	0	0	0	10	0	10	90	76	9	5
mulsion medium ..	100	8	16	22	21	0	11	78	6	0	6	16	0	14	2
o treatment (Control)	100	6	12	15	44	0	0	0	77	4	0	4	19	0	18

Table XII

Toxicity of DDT emulsions to eggs of C. cephalonica

Spray treatment	No. of eggs used	Hatches on		Total hatch		Eggs failed to develop		Eggs not hatched			
		4th day	5th day	No.	%	No.	%	Dead after development		Alive	
								No.	%	No.	%
1·25% DDT	132	5	4	9	6·8	27	20·5	20	15·2	76	57·6
2·5% DDT	185	0	6	6	3·2	32	17·3	84	45·4	63	34·1
5% DDT	190	4	4	8	4·2	33	17·3	99	52·1	50	26·3
Emulsion medium	135	33	52	85	63·0	22	16·3	6	44	22	16·3
Water	136	41	45	86	63·2	24	17·6	5	3·7	21	15·4

Table XIII

Effect of Acrylon fumigant on germination of maize seeds

Water content of seeds	Dosage of fumigant lb./1000 c.ft.	% germination after fumigation		
		After one month	After 2-3 months	After 5-6 months
11	Control	99	99	99
11	3	100	98	99
11	5	82	98	99
11	Saturated vapour	94	98	90
13	Control	75	98	99
13	3·5	49	97	99
13	5	51	99	99
13	Saturated vapour	1	5	3
16	Control	73	99	99
16	3	17	98	96
16	5	40	98	96
16	Saturated vapour	0	0	0

REPORT OF THE DIVISION OF MYCOLOGY AND PLANT PATHOLOGY FOR THE YEAR 1950-51

BY

DR. R. S. VASUDEVA

SECTION OF PLANT PATHOLOGY

1. *Wheat*:

(*a*) *Rust* (*Puccinia graminis tritici* Eriks. & Henn., *P. triticina* Erikson, *P. glumarum* (Schmidt) Eriks. & Henn.) :—Studies on the physiologic races of Black, Brown and Yellow Rusts of wheat were continued. Collections, numbering 104, of rusts made from different wheat and barley varieties and different localities from all over India were analysed and it was found that races 21 and 42 of Black Rust, races 63 and 20 of Brown Rust and races 19 and A of Yellow Rust were predominant and were widely distributed throughout the country. Other races met with, arranged in order of prevalence, were 40 and 34 of the Black, 106, 108 and D of the Brown and 20, 31, A, E and H of the Yellow Rust.

A search for the collateral and alternate hosts of the wheat rust fungus was continued. One collection of *Andropogon* sp. from Orissa, affected with rust has yielded Race 34 of *Puccinia graminis tritici*, which is the first record of occurrence of this race in that region. *Vulpia myurus* rust and *Briza minor* rust, collected from Nilgiris, yielded race 3 and races 3 and 7 respectively of *Puccinia graminis avenae*. The rust on *Agropyron semicostatum* collected from Simla proved to be *Puccinia graminis agropyri* and *Puccinia persistens*. Collections of several other grasses affected with rust e.g. *Bromus catharticus*, *Bromus japonicus* and wild barley, *Hordeum murinum*, etc. have been made and are being analysed for the determination of the physiologic races.

In the Varietal Resistance tests, 6,951 plants of various wheat varieties, their crosses and progenies, in the seedling stage and 14,370 plants in the adult stage were tested for their resistance to all the three rusts of wheat and their physiologic races. In addition 265 plants of various wheat varieties were also tested in the seedling stage for the Cereal Botanist, Punjab, but none of these proved resistant.

In the Seedling Resistance Tests, Simla hybrid strain 77, 79, 115 and 165, and exotic varieties E. 572, 579, 581 and 593 were found to be resistant to all the 9 Indian races of the Black Rust when tested individually. But when the mixture of these races of the Black Rust were used as inoculum, the following varieties reacted as resistant : E. 336, 505, 569, 592, 741, 744, 874, 875, 877, 879, 909, 910, 924, 931, 940 and 951 ; Fixed hybrids W.206, plants 4, 9 and 40 ; W. 246, plants 8, 9, 18, 38 and 41.

As regards the Brown Rust, variety E. 80 proved resistant to all the 8 Races of the Brown Rust found in India when tested individually ; whereas varieties E. 699, 928, 938, 956 and 957 reacted as resistant to the mixed inoculum of all these 8 Races.

In the case of Yellow Rust, wheat varieties E. 147, 620, 627, 630, 671, 672 and 687 proved resistant to the 10 Indian Races of the Yellow Rust when tested against each individually ; while varieties E. 336, 446, 555, 740, 928 and 938 reacted as resistant to a mixture of all these 10 Races.

In the experiments where 50 cultures belonging to 5 experimental crosses and 44 Exotic varieties were tested against all the 27 races (mixture) of the three rusts of wheat known to occur in India, only one variety, E. 952, proved resistant.

In the Adult Resistance Tests 36 Exotic varieties, 9 hybrids and 10 fixed hybrids were found resistant to a mixture of all the 9 Indian Races of the Black Rust ; 31 Exotic varieties reacted as resistant to a mixture of the Indian races of the Brown ; and 37 Exotic varieties proved resistant to a mixture of the 10 Indian Races of the Yellow Rust. When a mixture of all the 27 races of Black, Brown and Yellow Rusts was used as inoculum, 19 cultures belonging to 6 crosses in F3 generation proved resistant. Out of the 124 cultures of the Delhi Material four reacted as resistant.

(*b*) *Smut* (*Ustilago tritici* (Pers.) Rostrup) :—Investigations on the Loose Smut of wheat were continued in co-operation with the Division of Botany. The crop raised from the 112 varieties of wheat which were inoculated with a mixture of L_1 and L_2 isolates and L_4 isolate of the wheat Loose smut fungus during the previous season (1949-50) showed that with a mixture of L_1 and L_2 isolates, 62 varieties did not take infection. 32 developed infection upto 20 per cent ; 10 showed more than 20 per cent infection ; and 8 above 50 per cent infection. With L_4 isolate, 58 varieties remained without infection ; 41 showed upto 20 per cent infection ; and 10 developed more than 20 per cent infection. Fifty three varieties failed to take infection either with the mixture of L_1 and L_2 or L_4 isolate and may, therefore, be regarded as resistant.

During the present season (1950-51) about 3,400 wheat ears of 175 varieties have been inoculated with isolate L_4 and mixture of L_1 and L_2 for the varietal resistance test.

Physiologic Races :—Sixteen varieties, representing five species of *Triticum*, were inoculated in the previous year with Loose Smut isolates L_1, L_2, L_3, L_4, L_6, L_7, L_8, L_{10} and A_{10}. Seed from the inoculated ears was sown during the present season to study the disease development in the resulting crop. The infection was rather poor ; being totally absent in 13 varieties out of the 16 inoculated and being only slight in the remaining three viz. C.591 (Highly susceptible), E.144 and E.14. No conclusions could, therefore, be drawn regarding the identity of the physiologic races among the collections tested.

During the current year (1950-51) inoculations have been made on the differential varieties with 25 collections of *Ustilago tritici* including the 9 tested last year.

(*c*) *Foot Rot* (*Fusarium* sp.) :—The disease appeared in a fairly severe form in the wheat crop of certain neighbouring villages during December, 1951 ; the incidence of the diseased seedlings being about 20 per cent. Most of the diseased plants studied yielded, on isolation, a species of *Fusarium*, which has proved highly pathogenic in pot experiments under controlled conditions. Further studies of the disease and the causal organism are in progress.

(*d*) "*Tundu*" *Disease* (*Corynebacterium tritici* (Hutchinson) Bergey *et al*) :—The disease is observed to be on the increase in the wheat crop near about Delhi, causing a loss of upto about 30 per cent of the crop in the badly affected fields. Isolations made from the diseased specimens invariably gave pure cultures of a bacterial organism which after morphological and cultural studies has been identified as *Corynebacterium tritici* (Hutchinson) Bergy *et al*. The disease was easily reproduced by mixing the galls with healthy wheat seed and sowing the two together ; but the disease could not be reproduced with the pure culture of the bacterium isolated. The presence of nematodes appears to be essential along with the *Corynebacterium* to bring about the disease. October-sown crop showed appreciably greater infection of the disease than the November-sown ; and that excessive irrigation greatly increased the disease incidence, particularly in the October-sown plots. The disease has been found to be completely controlled by the removal of the nematode galls by floatation or sedimentation. The Solar Treatment of infected seed failed to control the disease.

2. *Barley* :

(*a*) *Rust* (*Puccinia graminis tritici* Eriks. & Henn. and *P. glumarum* (Schmidt) Eriks. & Henn.) :—Seven collections of barley affected with rust, collected from different localities, were analysed for the determination of the physiologic races of the rust. Race 21 of Black Rust was commonly found in the samples from Bihar : Races 19 and G of Yellow Rust in the Punjab and Race 13 and 19 of Yellow Rust in U. P.

For the Varietal Resistance Tests 1,304 plants of different barley varieties were tested for their rust-resistance in the seedling stage and 2,330 in the adult stage. In addition 171 plants of barley varieties received from the Cereal Botanist, Punjab, were also tested for their resistance to rust in the seedling stage.

No variety of barley was found to be resistant in the seedling stage to all the 9 races of the Black Rust tested individually. Barley variety, B. 216, reacted as resistant to all the 10 races of the Yellow Rust. None of the Barley varieties received from Punjab proved to be resistant in the seedling stage when tested against a mixture of all the 10 races of Yellow Rust and 9 of Black Rust.

In the Adult Resistance Tests, however, of the various Barley varieties received from the Botany Division, Indian Agricultural Research Institute, 8 were found to be resistant to all the 10 races of the Yellow Rust.

(*b*) *Loose Smut* (*Ustilago nuda* (Jens.) Rostr.) :—Efficacy of Solar Treatment of seed for the control of Loose Smut of barley reported last year, has been confirmed. Infected barley seed was soaked in cold water for 1, 2, 3 and 4 hours and then exposed to sun on a brick floor for 4½ hours during June 1951. The seed so treated was sown in November, 1951. The untreated seed was simultaneously sown in the two adjoining plots. The disease in the plots sown with the seed soaked for 3 hours and 4 hours and exposed to sun for 4½ hours was completely controlled and the germination was 90 per cent and 88 per cent respectively as compared to 96 per cent of the untreated control.

3. *Jowar* :

Grain Smut (*Sphacelotheca sorghi* (Link) Clinton) :—The possibility of extending Solar Treatment for the control of Grain Smut of Jowar was indicated last year. Various schedules of seed treatment regarding soaking in cold water and exposure to sun were tried but unfortunately the untreated control gave poor germination (17·5 per cent) and low smut infection (2·5 per cent). However, in the treatment where the seed was twice soaked and twice exposed or twice soaked and once exposed (50·5-52°C) the disease was completely controlled but germination was greatly impaired. In the treatment where the seed was once soaked (for 4 hours) and once exposed to sun (4 hours) the disease incidence in the resulting crop was only one-third that of the untreated control, thus clearly indicating the possibility of controlling the Grain Smut of jowar by Solar Treatment of infected seed and confirming last year's results. Further experiments to evolve a suitable schedule of seed treatment for controlling the disease without appreciably impairing the germination are in progress.

Preliminary experiments show that the disease is not soil-borne.

4. *Sugarcane* :

Study of the diseases of sugarcane with particular reference to Red Rot and Smut, and the study of the physiologic forms of the Red Rot fungus were in progress.

In addition, with the collaboration of the Government Sugarcane Expert, Coimbatore, experiments have been in progress to study the inheritance of disease resistance, with a view to evolve cane varieties resistant to Red Rot and Smut, and to study the Red Rod and Smut resistance of certain selected cane varieties, *S. spontaneum* and other *Saccharum* species. Altogether about 22,500 canes and 10,000 cane setts were inoculated in the various tests at Delhi, Karnal and Coimbatore.

(*a*) *Red Rot* (*Colletotrichum falcatum* Went) :—In order to select resistant cane varieties for general cultivation and cane breeding work, testing of varieties for their resistance to Red Rot was continued. About 260 cane varieties have been tested so far. During the present season (1950-51) 94 important parent cane varieties including *Saccharum spontaneum* and other *Saccharum* spp.were tested for their resistance to Red Rot by the standard Plug Method. Of these 4 reacted as highly resistant and, 59 as moderately resistant. Most of these varieties have reacted as such during the previous tests. All these 94 varieties were also tested for their resistance to nodal infection which is the chief mode of infection in nature. Eighteen varieties reacted as resistant, including the four which reacted resistant in the Plug Method test also.

In the physiologic forms studies of the Red Rot fungus, 32 *C. falcatum* isolates obtained from different localities and different cane varieties were tested on 10 differentials. Judging by the linear spread of infection the light type, highly sporing isolates generally proved more virulent than the dark sparsely sporing ones ; but there appears to be little specificity between the isolates and the cane varieties tested. Isolates recently obtained from Red Rot epidemic areas of eastern Punjab have proved highly virulent.

Experiments to test the relative susceptibility to Red Rot of cut canes and standing canes show that the results are not congruent in the two methods except in the case of highly susceptible varieties. Experiments were also in progress to study the variation in cultural characters of 32 *C. falcatum* isolates.

(*b*) *Smut* (*Ustilago scitaminea* Syd.) :—The smut varietal resistance test was carried out with 87 varieties, including important parent cane varieties and *Spontaneum* and other *Saccharum* spp., at Karnal ; and with 94 varieties, including those newly released by the Sugarcane Breeding Station, Coimbatore, at Delhi. Of these, 26 varieties have shown less than 5 per cent infection whereas the maximum infection obtained under the experimental conditions was 90-100 per cent both at Delhi and Karnal and may thus be regarded as highly resistant. Sixteen of these have been tested during the previous five seasons and reacted as resistant.

(*c*) *Evolving sugarcane varieties resistant to Red Rot and Smut* :—Experimental crosses have been effected with selected cane varieties of known resistance to Red Rot and Smut and their progenies are being tested for inheritance of Smut and Red Rot resistance in order to select only such cane varieties for future cane breeding work that transmit the desirable disease resistant character to a large proportion of the progeny. The seedlings are now in the second ground nursery stage and will be inoculated shortly. This work is being carried out in collaboration with the Government Sugarcane Expert at Coimbatore.

(*d*) A *Sphacelotheca* type of Smut hitherto unreported on sugarcane was found affecting two cane varieties, Co. 560, and Co. 561, at Karnal.

(*e*) *Rust* (*Puccinia kuehnii* (Krueg.) Butler) :—The Rust which is normally of very rare occurrence on sugarcane in India was reported to be prevalent again this season in Bombay State on Co. 475 but has not spread so far to any other cane variety or Co. 419 which is the Chief Commercial cane variety of that State. The Rust though present on certain *S. spontaneums* at the Sugarcane Breeding Station, Coimbatore, has not so far been found to infect any of the large number of cane varieties grown there.

5. *Gram*:

(*a*) *Wilt* :—A large number of isolations made from wilted gram plants yielded *Fusarium orthoceras*, *Operculella padwicki*, *Rhizoctonia solani*, *R. bataticola*, *Sclerotium rolfsii* and *Neocosmospora vasinfectum*. Soil infection experiments were conducted with all these fungi. *F. orthoceras* and *O. padwickii* were found to produce 90-94 per cent mortality of plants but typical wilt symptoms were produced only with *F. orthoceras*. Yellowing and shedding of the lower leaves was caused by *S. rolfsii* in 58·4 per cent plants. *R. bataticola* and *Neocosmospora* infected 9·6 per cent and 3·7 per cent plants respectively but the symptoms produced were quite distinct from that of wilt. A wilt-sick plot is being established for further experimental work.

A species of *Pythium* was obtained from diseased gram plants collected from the wilt-sick plot which was found to be capable of causing severe seed rotting. Cultural and morphological studies of the causal organism are in progress for the identification of the pathogen.

6. *Linseed*:

Rust (*Melampsora lini* (Pers.) Lev.) :—One hundred and twenty-five cultures of linseed hybrids different from those tested during the previous years were inoculated with a mixture of 4 Indian physiologic races of the linseed rust in seedling and adult stages. Altogether 1,562 seedlings in pots were

ested in the glasshouse and 3,000 adult plants in the field. The inoculum of the physiologic races vas obtained from the Rust Research Laboratory Simla, and was multiplied on a highly susceptible variety, N.P. 21, in the glass-house and then mixed together prior to inoculation. One hundred and four cultures proved immune or resistant both in the seedling and adult stages : seven cultures reacted as semi-resistant ; two reacted as semi-resistant in seedling stage and resistant in adult stage : three proved to be susceptible and four gave mixed reaction. Five cultures gave mixed reaction in the seedling stage but reacted as resistant in the adult stage.

Experiments were in progress to study the inheritance of pathogenecity in the physiologic races I_1 and I_2 of the linseed rust. The selfed aecial material of race I_1 and I_2 was tested at Simla for the determination of the physiologic races and were found to resemble the parent races in their pathogeneity on the differential hosts and the two races, therefore, appear to be homozygous. It would however be necessary to test the F_2 generation of the two races to arrive at any definite conclusion.

Nine samples of Linseed Rust collected from U.P., Madhya Pradesh and Bihar were analysed and Races I_1, & I_3 were encountered.

. *Pigeon-pea* :

Wilt (*Fusarium udum* Butler) :—Twenty varieties of Pigeon-pea were tested for their resistance o Wilt disease both in a heavily infected wilt-sick plot and in artificially infected soil in pots by mixing ure cultures of the wilt fungus growing on soil-maize-medium. Field tests were carried out in a permanent plot which was wilt-sick and to which wilt infected roots of pigeon-pea are added every season n rows along which sowing is to be done, so as to provide optimum conditions for infection. Three varieties viz. N.P.41, C.38-1-2 and D 419-2-4 reacted as highly resistant both in the field and pot tests. These three varieties had reacted as resistant in last year's tests also.

. *Antibiosis* :

Investigations on the analysis of the factors governing suppression of activity of *Fusarium udum*, he Pigeon-pea wilt organism, were continued. The role of five associated soil-micro-organisms *i.e.* *Aspergillus niger*, *A. terreus*, *Cunninghamella elegans*, *Rhizoctonia bataticola* and *Rhizopus nigricans* on the activity of *F. udum* was studied. The growth of *F. udum* in culture was checked by the filtrates of *A. niger* and *R. nigricans* which has been ascribed to the high acidity of the filtrates. The filtrates with pH adjusted to 6·0 did not adversely affect the growth of *F. udum*. The addition of the filtrates o the maize-soil-medium failed to check the growth of the fungus to any appreciable extent. In the pathogenecity tests conducted in sterilized soil in pots it was observed that where simultaneous inoculations with the saprophytic fungi and the pathogen were made, only *R. nigricans* was effective in markedly reducing the wilt incidence and *C. elegans* only to a slight extent, whereas *R. bataticola* proved almost neffective. In the series where soil saprophytes were given a start of 15 days over the pathogen it vas observed that only *R. nigricans* reduced the wilt incidence to any appreciable effect. In both the eries of experiments the presence of *A. terreus* appeared to increase the virulence of the pathogen. With mixed inocula of all the 5 saprophytic organisms a considerable reduction in the incidence of the lisease was, however, observed. The effect of cultural filtrates on the parasitic activity of *F. udum* nas shown that the filtrates of *R. nigricans* and *C. elegans* were effective in checking the wilt incidence nd that of *R. bataticola* showed only slight reduction. All the five filtrates together, however, resulted n appreciable reduction in disease incidence.

It has been observed that *R. nigricans* and *C. elegans* are much faster growing than *F. udum* on he soil-maize medium in glass columns.

. *Fungicides* :

(*a*) Experiments were conducted to test the relative efficacy of some common seed-dressing fungicides on emergence, stand and yield of Maize (variety Yellow N.P.2), wheat (N.P.715) and barley

(N.P.13). The germination, stand and yield of the maize, wheat and barley crops of the plots sown with seed treated with different fungicides and the untreated control were as follows :

	Agrosan GN	Barbak	Spergon	Copper carbonate	Control
Maize : Germination (%)	72·9	77·1	77·5	75·8	66·4
Surviving stand (%)	67·5	74·5	74·0	72·0	64·0
Yield (cob. wt.)	94 lbs.	150 lbs.	114 lbs.	114 lbs.	108 lbs.

	Agrosan GN	Aagrano	Spergon	Ceresan	Lunasan	Control
Wheat : Stand ($4\frac{1}{2}$ ft. Length) (No. of Tillers)	70	77	63	85	Not tested	82
Yield (Grain) ..	88·5 lbs.	84·1 lbs.	90·3 lbs.	100·7 lbs.	..	83·9 lbs.
*Barley** : Stand ($4\frac{1}{2}$ ft. Length) (No. of Tillers)	80	48†	82	59†	102	82
Yield (Grain) ..	35·5 lbs.	34·0 lbs.	37·3 lbs.	41·0 lbs.	40·5 lbs.	31·8 lbs.

* Sown very late.
† Rat damage.

It will be seen from the data that in the case of maize the treatments with Agrosan GN and Barbak gave 18·75 per cent and 16·5 per cent better germination than the untreated control. The stand was 52·8 per cent better with Parbak and 41·7 per cent better with Spergon. Maximum yield was obtained with Parbak treatment which showed 39 per cent increase over the control. In the case of wheat, best stand and yield was obtained with Ceresan treatment which showed an increase of about 20 per cent in yield. As regards barley Lunasan treatment gave 12·6 per cent increase in stand and 27·6 per cent increase in yield. With Ceresan an increase in yield of 29·1 per cent was observed.

The relative effectiveness of 12 fungicides on the germination of barley and jowar as a result of seed treatment with different doses of the fungicides was tested under laboratory conditions. In the case of barley Barbak (5 : 1000 and 3 : 1000), Spergon (10 : 1000 and 7 : 1000), Agrosan GN (3 : 1000 and 5 : 1000), Ceresan (3 : 1000 and 5 : 1000), Semesan (4 : 1000 and 2 : 1000), Copper carbonate (3 : 1000), Lunasan (2·7 : 1000) gave 96·6, 95, 96, 92, 93·6, 98·3, 90·3, 88, 90, 91·3, 89·6 and 96·6 per cent germination as against 71·3 per cent of the untreated control. The corresponding germination figures of jowar with similar treatments are 96·5, 95, 96, 96·5, 98·5, 92·5, 90, 88·5, 89, 93·5, 86·5, and 96·5 per cent, while that of the control was 66·5 per cent.

Last year a hydrophobic colloidal sulphur spray, prepared by using sulphur, lime and molasses, was used on a laboratory scale with success in the control of Black Rust of wheat. During the current year the spray was tried on a field scale on twenty four plots (each measuring 15 ft. $\times$10 ft.) sown with a highly susceptible variety (Agra local). Twenty-four different prophylactic or therapeutic treatments were tried. No appreciable control of the disease could be obtained in any of the 24 series in plots artificially inoculated with rust. In naturally infected crop the weekly and fortnightly sprays showed some reduction in the rust incidence ; but the natural infection of the crop this year was very low and no conclusion can be drawn from this experiment. The spray is found to be easily washed off and some suitable sticker is being added to it for further trials.

10. *Assessment of damage* :

Experiments along the lines carried out during the previous two years to assess losses caused by Black Rust of wheat, Rust of linseed, smut of sugarcane and Tomato Leafcurl in order to determine the economic importance of these diseases were continued.

Reduction in yield due to Black Rust of wheat on the basis of 1000-grain weight in relation to intensity of infection was determined in the case of two wheat varieties *viz.* Agra Local and N. P. 4. Plants showing infection below 5 per cent, 10-25 per cent and 40-50 per cent were harvested separately. Taking 1000-grain weight from plants showing below 5 per cent infection as the standard, a reduction in yield of 14·2 per cent and 19·6 per cent with 10-25 per cent and 40-50 per cent rust infection respectively was observed in Agra Local variety. The corresponding figures for N. P. 4 were 7·9 and 13·1 per cent. On account of the late appearance (17-3-51) of the Black Rust this year and milder attack no plants with very heavy rust infection (75 per cent or over) could be collected.

Assessment of reduction in yield due to linseed rust was undertaken with six linseed varieties (N. P. 1, 11, 12, 21, 121 and 124) on lines similar to wheat rust as well as on 10-plant yield basis. It was found that with 40-50 per cent infection the losses in grain yield varied from 3·1-20·4 per cent in all the 6 varieties ; and with 75 per cent or over infection the loss revealed was 10·5-32·5 per cent. On the basis of total yield from 10 plants picked up at random the losses were observed to be 11·1-44·5 per cent with 40-50 per cent infection and 36-58·8 per cent with 75 per cent or over infection. The difference is probably due to the fact that the number of flowers and seeds formed is more adversely affected than the grain weight. Observations in this direction would be recorded in further experiments.

In the case of sugarcane smut a reduction in yield of 15·5 per cent and 41·8 per cent in Co. 312 and Co. 313 respectively was observed when the setts were artificially infected at the time of planting. Greater loss in yield was however, observed when setts from smutted canes were planted : the losses being 71 per cent in Co. 312 and 73·3 per cent in Co. 313.

In Tomato Leafcurl, the average yield per plant affected with the disease was 11·3 oz. as compared to 32·8 oz. from healthy plant thus showing a reduction of about 66 per cent.

11. *Miscellaneous* :

(*a*) *Soft Rot of Vegetables and Fruits* :—A survey of bacterial diseases causing soft rot of fruits and vegetables was made in Delhi markets. It was found that the diseased coconut and pear fruits were affected with *Bacillus subtilis* ; potatoes with *Erwinia caratovora* and *Bacillus mesentericus* ; onions with *Pseudomonas marginalis* ; tomatoes with *Erwinia aroideae* ; and peas with an *Erwinia* sp. which appears to be an intermediate strain between *E. caratovora* and *E. aroideae*.

Soft rot of potatoes was studied in some detail. Comparative cultural, morphological and pathogenecity studies of *Erwinia caratovora*, *E. aroideae*, *E. atrospetica* (Black-leg organism) have shown that *E. aroideae* differed from *E. caratovora* only in not being able to produce gas from carbon compound and may therefore be regarded as a non-gas producing strain of *E. caratovora*. *E. atroseptica*, however, differed from *E. caratovora* and *E. aroideae* in the utilization of certain carbon compound, *viz.*, maltose, glycerol ethylialcohol, and in temperature relationship and thermal death point. Moreover *E. atroseptica* alone is capable of producing the typical Black-leg symptoms on potato plants. All the three isolates have been found to be capable of producing rot of potato tissue ; *E. caratovora* being the most virulent. *E. caratovora* produced maximum attack at 25°C ; *E. atroseptica* at 20°C and *E. aroideae* at 30°C at relative humidity of 90-100 per cent. Even a very low humidity of 10 per cent failed to prevent the three organisms from producing rot at 20°C. But when low himidity (upto 35 per cent) is combined with low temperature (4°C) no rot was produced by any of the three organisms. *E. caratovora* and *E. atroseptica*, however, were found to produce slight amount of rot even at 4°C under conditions of high humidity (65 per cent or over). *E. aroideae* failed to produce any rot at 4°C even with 90-100 per cent humidity. *B. mesentericus* proved to be almost saprophytic.

Investigating the question of Ring Rot of Potatoes, it has been found that the isolates obtained from the diseased specimens received from Madras and Bombay closely resemble *Pseudomonas solanacearum* indicating thereby that it is the Brown Rot of Potatoes, and not Ring Rot, that is prevalent in Madras and Bombay States.

(*b*) *Air-borne fungal spores*:—To enable forecasting of airborne fungal diseases, particularly Rusts, and to study the variations in the fungal flora of the air at different times of the year glass slides smeared with vaseline were exposed in aeroscope, about 3 ft. above the ground level, twice a week during December to April and once a week for the rest of the year. Spores of *Alternaria* and *Helminthosporium* were trapped all the year round ; *Darluca* sp. was common during July ; and smut spores were abundant during December to April. The uredospores of *Puccinia glumarum* were first detected on 13th January, 1951 and of *P. triticina* on 24th February, 1951 ; two solitary uredospores of *P. graminis* on 22-24th February, 1951, as also the uredospores of linseed rust. It has been possible to correlate the first spore shower with initial wheat rust outbreaks. It might however, be mentioned that artificial rust inoculations of wheat had been undertaken in Botany Division.

(*c*) *Microflora of Stored Grains*:—These studies were carried out with 12 varieties of barley (N. P. 13, 17, 18, 24, B. 1, 119, 216, 245, Agra Local, Patiala Old, Patiala New and U. P. Farmers and 12 varieties of jowar (Co. 1, 3, 4, 9, 11, Y. 15, J. 263, JPB. 1 K, T. 8P, Yellow 15, Jowar local and Jowar Red local). In the case of barley, spores of *Alternaria*, rust, smut and *Fusarium* whereas in jowar spores of *Alternaria*, *Fusarium*, *Helminthosporium* and smut were observed in the seed washings. Isolations made from barley and jowar samples of the above mentioned varieties, by planting out 100 seeds after surface sterilization in each test on Potato Dextrose Agar (Adjusted to pH 7 and pH 4·5) and Smith-Humfeld Agar, yielded predominantly a species of *Alternaria* in the case of barley and *Rhizopus* from jowar seeds. The role of these organisms on germination and the beneficial effect of fungicidal seed dressing treatment has been studied.

The relative proportion of the various epiphytic fungi observed in the case of barley seeds of 12 varieties was *Alternaria* 38-71 per cent, *Aspergillus* 4-34 per cent and *Fusarium* 4-18 per cent whereas in the case of jowar seeds (12 varieties) the relative infestation was *Rhizopus* 38-69 per cent, *Aspergillus* 4-62 per cent and *Fusarium* 2-18 per cent. As regards the endophytic flora, *i.e.*, the growths obtained from the seeds after surface sterilization, the barley samples showed 4-18 per cent, *Alternaria*, 2-7 per cent *Helminthosdporium* and 1-2 per cent *Fusarium* ; and the jowar seeds gave 2-18 per cent *Rhizopus*, 2-9 per cent *Aspergillus*, 2-9 per cent *Alternaria* and 2 per cent *Fusarium*.

B. Section of Plant Viruses

12. *Bottlegourd* (*Lagenaria leucantha* (Duch.) Rusby) :

Mosaic (*Cucumis virus* 2C) :—It has been shown that bottlegourd mosaic virus is carried symptomlessly on the inoculated leaves of *Datura stramonium*, *Nicotiana tabacum*, *Nicotiana tabacum* var. *White burley*, *Solanum nigrum* and *Solanum nodiflorum* but fails to infect *Lycopersicum esculentum* and *Capsicum annuum*. It has also been shown that in the case of *Datura stramonium* and *Nicotiana tobacum* the virus remains confined to the inoculated portion of the leaves and does not move from the inoculated point. Some preliminary attempts to make the virus move farther from the inoculated portions of the leaves have so far been unsuccessful.

It has also been shown that the leaf extracts of *Datura stramonium* and *Capsicum annum* markedly inhibit the activity of the virus and that the infectivity of the virus is further affected by the prolonged storage of the virus with these extracts. The greater the storage period, more marked is their inhibitory effect. The extracts from old *Datura* plants show greater inhibition of the virus than the extracts from young plants and that there is a fall in the toxicity of the leaf extracts when diluted. The fact that the inhibitory effect is lost on heating and dilution with water and is unaffected on dessication indicates that some toxic principle is involved. The concentration of such principle in the mixture determines the inhibitory property of the extract. Evidently the concentration of the toxic principle in young *Datura* plants is not high enough to inhibit the virus appreciably at the dilutions tested, and as the plants grow old, the toxic principle in the leaves markedly increases.

Further work is, however, in progress to determine the critical points at which the virus is being adversely affected by cell-sap of different plants of *Solanaceae*, particularly in relation to the period of interaction, as also to determine conditions under which the virus may extend farther from the inoculated parts of the plant.

13. *Tomato* (*Lycopersicum esculentum* Mill.) :

Leaf Curl (*Nicotiana Virus* 10) :—Attenuation of the virus by passage through *Capsicum annum* has been confirmed by repeated grafting tests. The attenuation of the virus after successive passage through Tomato and *Datura* by grafting and double grafting has been observed ; a severe strain of the virus after passage through these two hosts produced infection of very mild nature. Whether such attenuation would still take place if the transmission of the disease to tomato and *Datura* is effected with the insect vector is being studied.

Tobacco shoots affected with severe type of Leaf Curl infection, after being dipped for five hours in *Capsicum annum* leaf juice, produced, when grafted on healthy tobacco plants, the original severe type of Leaf Curl infection and symptoms.

Field experiments on the control of the disease by spraying with Fish-oil-Rosin-Soap have shown that bi-weekly spraying appreciably reduced the disease ; the incidence being 8·5 per cent in sprayed plots as against 13·2 per cent in the unsprayed controls. In another experiment where the sprayed plots were separated from the control plots by a border of maize crop, the disease incidence in the weekly sprayed plots was 8·8 per cent in the untreated controls. If the entire crop is sprayed *en bloc* the results are likely to be more encouraging. Observations on the insect and disease incidence showed maximum vector incidence in the month of October and the maximum disease incidence in November.

14. *Sannhemp* (*Crotalaria juncea* Mill.) :

Phyllody :—Experiments were in progress to study whether the disease is caused by the combined effect of Mosaic and Leaf-curl virus. Comparative studies of the properties of the mosaic component of the phyllody and the Sannhemp Mosaic virus have shown that both the viruses remained infective after exposure to 95°C. for 10 minutes as also at a dilution of 1 : 5000, proving thereby that the two are identical.

The juice from phyllody affected plants has been found to remain infective after 370 days' storage at 6-8°C. Further transmission tests with the vector of Leaf-curl are in progress.

15. *Hibiscus rosa-sinensis* :

Enation Mosaic :—Investigations into the host range and insect vectors of the disease were continued. The disease was successfully transmitted to *Hibiscus esculentus* both by the insect vector, *Bemisia tabaci*, and grafting. In both the cases typical enations on the young leaves were produced. The disease was transmitted by *B. tabaci* from artificially infected *H. esculentus* plants to healthy plants of *H. esculentus*. The disease was further successfully transmitted from *H. esculentus* to *H. rosa-sinensis* by grafting. These experiments indicate that the Bhindi Leaf-curl and *Hibiscus rosa-sinensis* enation Mosaic are caused by the same virus. Experiments on the insect transmission of the disease from diseased *H. esculentus* and *H. rosa-sinensis* to healthy *H. rosa-sinensis* are in progress. By grafting diseased *Bhindi* shoots, however, the disease has been successfully transmitted to Sakel cotton, cotton 4F, *Nicotiana tabacum*, *N. tabacum* var. *White Burley*, Tomato, *Datura stramonium*, *Solanum nigrum*, *S. nodiflorum* and *Zinnia elegnas*.

16. *Miscellaneous* :

(*i*) The mosaic disease of groundnut (*Arachis hypogaea*) was again transmitted to groundnut by grafting but could not be transmitted to *Nicotiana tabacum*, *N. tabacum* var. *White Burley*, *Datura stramonium*, cowpea, sannhemp and pigeonpea. Preliminary insect transmission tests were unsuccessful.

(*ii*) Transmission tests with a mosaic disease of *Nicotiana glauca* have shown that the disease is sap-transmissible and produced typical mosaic symptoms on *N. tabacum*, *N. tabacum* var. *White Burley*, *N. glutinosa*, *Capsicum annuum*, and *Petunia hybrida*. On *S. nigrum* it produced lesions on the leaves.

(*iii*) *Capsicum annuum* leaf-curl was successfully transmitted to a number of hosts. Transmission tests in connection with Lupin mosaic and mango inflorenscence malformation were taken up. Insect transmission tests of Brinjal mosaic with jassids (*Empoasca devastans*) to confirm the previous find ings were unsuccessful.

(*iv*) Disease-free tubers of various differential varieties of potatoes and *Darjeeling Red Round* w ere raised in the glass-house and tested for freedom from Virus infection.

C. Systematic Mycology

17. *Taxonomy* :

Fifty four specimens belonging to various genera, chiefly, *Cicinobolus*, *Myrothecium*, *Trtopileus*, *Phoma*, *Phyllosticta*, *Macrophomina* and *Cercospora* were under study. All of these are new records for India and some are new species. Studies on the Genus *Colletotrichum* were continued and 17 new hosts not hitherto recorded from India, were established. Studies on the Fungal Flora of Delhi have been undertaken. About 130 collections have been made and studied of which two appear to be new species and four new record for India. In addition 296 diseased specimens collected locally were studied of which 250 were fully identified and 44 half-named. In addition about 50 specimens received from different parts of the country were also identified.

18. *Indian Type Culture Collection* :

Sixty four cultures were added to the collection during the year and the total number of cultures in the collection is now 845. Seventy seven cultures were supplied to various research workers, Institutions and Industrial concerns in the country and abroad. Card Index of cultures in the collection was made upto date and a list of the Culture Collection has been prepared for circulation. Information available regarding the various cultures in stock was being compiled and entered on special Forms maintained for the purpose.

Studies on the preservation of cultures were in progress and the mineral oil preservation method was found suitable in the case of several fungi. Viability of sporing cultures stored in sand was also being tested. Cultures of *Phytophthora infestans* (Mont.) de Bary are being successfully maintained on the special medium, consisting of maltose, peptone and carrot-extract, developed in this laboratory.

19. *Herbarium Cryptogamie India Orientalis* :

Eighty-eight specimens of Indian fungi were added to the Herbarium during the year and the total number of specimens in the Herbarium is now 19,881. Seventy four specimens were supplied to various research workers and Institutions in the country and abroad. The preparation of the first Exsiccati Set to be issued by the Indian Agricultural Research Institute continued to receive attention and is now almost complete. The selection and study of the material for the second set is in progress.

PROGRAMME OF WORK FOR 1951-52

I. Plant Pathological Investigations :

(*a*) Studies on cereals smuts.

(*b*) Determination of physiologic forms of *Ustilago tritci*, *Melampsora lini*, *Puccinia graminis tritici*, *Puccinia triticina*, *Puccinia glumarum*, *Colletotrichum falcatum*.

(*c*) Wilt diseases of pigeon pea and gram as also other economic plants.

(*d*) Studies on rusts of wheat, barley, linseed sannhemp and wild grasses.

(*e*) Foot rot and Bacterial diseases of wheat.

(*f*) Green Ear disease of Bajra.

(*g*) Efficacy of different fungicides on stand, emergence and yield of crops and diseases ; as also the study of the microflora of seeds of economic crops.

(*h*) Assessment of damage due to some important plant diseases. Aerobiological studies.

(*i*) Varieties evolved by the Botany Division will continue to be tested for their resistance against diseases.

(*j*) Diseases of Sugarcane—Varietal resistance for Red Rot and smut and evolving of Red Rot and Smut resistant varieties. Also studies on the variation in *C. falcatum* and recurrence of Red Rot epidemic.

(*k*) Studies on microbial antagonism.

(*l*) Soft rot of vagetables, Brown Rot of Potatoes, and red stripe of sorghum, maize and sugarcane.

II. *Plant Virus Investigations* :

(*a*) Virus diseases of *Solanaceae, Leguminosae* and *Cucurbitaceae.*

(*b*) Examination of sugarcane mosaic virus for the occurrence of strains.

(*c*) Vectors of virus diseases under study.

III. *Mycological Investigations* :

(*a*) Taxonomy of fungi with particular reference to unidentified collections available in the Herbarium Crypt. Ind. Orient . as well as new collections.

(*b*) Maintenance of Indian Type Culture Collection of fungi and their history sheets and investigations to evolve methods for preservation.

(*c*) Additions to and maintenance of the Herbarium.

(*d*) Identification of fungi and diseased specimens.

IV. *Miscellaneous* :

(*a*) Maintenance of Host Index of Fungi ; preparation of card indices of species of fungi represented in India will be continued.

(*b*) Routine and Advisory, Post-graduate Teaching and Training and assistance and Advice to Indian Council of Agricultural Research, Indian Central Sugarcane Committee and Indian Central Oilseeds Committee in Mycological and Plant Pathological matters. Also co-ordination of Mycological and Plant Pathological research.

REPORT OF THE DIVISION OF AGRICULTURAL ENGINEERING FOR THE YEAR 1950-51

(Shri R. V. Ramiah)

GENERAL

The office and the workshop buildings of the Division were not built during this year also and as such the research activities had to be carried out on a restricted scale. At present the office and the workshop, are housed in the buildings of the Agronomy Division and due to the lack of proper accommodation, some machinery could not be unpacked and installed. The main activities of the Division had to be limited primarily to the servicing, maintenance and repair of machinery belonging to other

Divisions and also the maintenance and operation of farm and dairy machinery of the Division of Agronomy. Technical advice was given to the Agricultural Sub-Station, Karnal and Botanical Sub-Station, Pusa, whenever called for.

The following machines and implements were received for trial during the year :—

1. Japanese Grain Screen.
2. Japanese Seed Drill.
3. Japanese Weeder.
4. Japanese Rice Land Plough.
5. Massey Harris Milking Machine.
6. Surge Milking Machine.
7. Massey Harris No. 15 Tornado Feed Mill.
8. Viking Oil Bath Reaper Model D. O.

DEMONSTRATION OF MACHINERY AND TRACTORS

A. *Lanz Bull-Dog Tractor.*—At the instance of Messrs. Hindustan Electric Co., Delhi the demonstration of a Lanz Bull Dog Tractor manufactured in Germany was carried out at the Institute Farms in the presence of the Honurable Shri H. K. Mehatab, Minister for Commerce and Industry. The occasion was attended to by some of the Ministers of the Central Government, the press and the public.

B. *Allis Chalmers' 'B' Tractor.*—This tractor was demonstrated at the Botanical Farm of the Institute by Messrs. Pashabhai Patel and Co., Bombay in the presence of the Honourable Prime Minister, Minister for Food and Agriculture and the Minister for Health. Later one of the tractors was presented to the Honourable Prime Minister by the representatives of the manufacturers.

C. *Bone-Crusher.*—A demonstration of the portable Bone-Crusher, driven by an Allis Chalmer 'B' Tractor, was given at the Jaisalmer House by this Division. The demonstration was arranged at the request of the Honorary Bone-Meal Adviser to the Government of India and was attended to by the Honourable Shri K. M. Munshi, Minister for Food and Agriculture and several members of Parliament.

D. *Petter Diesel Engine.*—A 5 Horse Power Petter Diesel Engine was presented to the Honourable Shri K. M. Munshi, Minister for Food and Agriculture by Messrs. Parry & Co., New Delhi at a function in the Imperial Hotel. The engine was sent to this Division for use by the Honourable Minister.

RESEARCH

Tractor Operating Costs and Operational Rates.

The following wheel type tractors were put into commission and tried in various field operation during the year under report. The cost of their operations and operational rates have been worked out and are given below :—

A. *Farmall 'H' Tractor.*—Manufactured by Messrs. International Harvester Co., Chicago, U.S.A. and has a 4-cylinder kerosene engine (petrol starting) with 21·37 D.B.H.P.

OPERATION RATES AND COSTS (including charges on implements)

Operation	Hours worked	Acres done	Acres per hour	Cost per acre in Rs.
Ploughing	112·33	75·97	0·67	8·18
Discing	265·00	491·95	1·86	2·95
Grubbing	136·67	268·00	1·96	2·75

B. *Allis Chalmer 'B' Tractor.*—Manufactured by Messrs. Allis Chalmer Co., U.S.A. It has got a 4-cylinder kerosene engine (petrol starting) with 20·6 D.B.H.P. This tractor was presented to the Honourable Prime Minister by Messrs. Pashabhai Patel and Co., Bombay, last year.

OPERATIONAL RATES AND COSTS (including charges on implements)

Operation	Hours worked	Acres done	Acres per hour	Cost per acre in Rs.
Ploughing	44·00	17·02	0·39	9·66
Discing	11·00	23·30	2·12	1·79
Grubbing	5·00	10·00	2·00	1·86

C. *Ferguson Tractor.*—Manufactured by Messrs. Harry Ferguson & Co., England. It has a 4-cylinder petrol engine with 20·7 draw bar horse power.

OPERATIONAL RATES & COSTS (including charges on implements)

Operation	Hours worked	Acres done	Acres per hour	Cost per acre in Rs.
Ploughing	47·75	35·25	0·738	6·02
Discing	142·83	257·25	1·801	2·41
Grubbing	139·55	238·55	1·708	2·54

Operational cost per hour (excluding charge on implements)
For operation of the tractor only.

	Formall 'H'	Allis Chalmer 'B'	Ferguson
Purchase Price	Rs. 10,300	Rs. 6,000	Rs. 6,500
Total usage in hrs.	649·00	138·75	520·00
	Rs.	Rs.	Rs.
1. Fuel (*a*) Kerosene	1355·62	183·00	..
(*b*) Petrol	129·28	26·66	1249·00
2. Labour	527·49	114·51	422·56
3. Maintenance servicing and spare parts	54·35	25·83	111·34
4. Lubricants	124·25	11·30	60·06
5. Depreciation	860·58	104·06	212·56
6. Interest	250·73	30·77	127·23
7. Total	3302·33	493·13	2182·75
Total hours worked	649·00	138·75	520·00
Cost per hour	5·24	3·57	4·20

Acreage of ploughing per hour by Allis-Chalmer tractor is low because only one furrow plough was used. The Ferguson Tractor is suitable for follow-up cultivation and road transport duties, having a suitable road speed.

MANURE SIEVING MACHINE

After the preliminary trials carried out last year, at the Badli Manure Dump, the following modifications have been made to facilitate the working of the machine as well as to achieve better results. (1) The canvas elevator has been changed to all-metal chain elevator in order to get a continuous, trouble free service. (2) The hopper has been redesigned to suit the scoop of the mechanical loader fitted with the Farmall ' H ' tractor. (3) An elevating platform, to raise the height of the tractor while feeding the hopper, has been fabricated with Mild Steel plates. (4) The drive to the elevator has been improved by chain and sprockets. (5) An engine of higher power has been fitted to the screen.

The modified machine was taken to the Badli Dump and was tried in the presence of Sir Datar Singh, Additional Secretary Ministry of Food & Agriculture, Mr. Rameshwar Dayal, Deputy Commissioner, Delhi and Dr. R. P. Talati, Compost and Sewage Development Officer, Ministry of Food and Agriculture. The Machine as a whole worked satisfactorily and gave an output of 24 tons of finished manure per day of 8 hours. A hand operated rotary screen was also tried simultaneously and the output was found to be the same as that of the engine operated screen. The cost have been worked out to be Rs. 2-10-0 and Re. 1 per ton respectively.

It has been found that even though the cost of production is higher, the engine operated screen would be useful, where labour is not available even at high rates.

TRIAL OF JAPANESE AGRICULTURAL IMPLEMENTS

(*a*) *Bullock Drawn Cultivator* :—A bullock drawn three tined cultivator, imported from Japan was put into operation and was found suitable for preparing seed beds of crops like maize, cotton, etc., after the field had been ploughed by a soil inversion or desi plough. This is also suitable for making ridges in the farm with the help of an additional attachment, which has been supplied with the implement. It can also be used for weeding purposes, that is for inter-row cultivation, etc. The following are the details of performance of the cultivator :—

1. Condition of the field	Wet, covered with weeds of 3″ to 4½″ height once disced.
2. Nature of soil	Sandy loam (wet).
3. Crop harvested previously	Maize.
4. Average depth of furrow	2½″ to 3″.
5. Average width of furrow	Do.
6. Average output per hour	0·252 acres.
7. Average draft	168 lbs.

The cultivator is handy, cheap and suitable for individual ownership. The average draft of a Delhi Bottom Plough is about 160 Lbs. and as the draft of this cultivator is nearly the same, it can conveniently be worked with an average pair of bullocks.

(*c*) *Grain Screen* :—Four grain screens have been imported from Japan in order to find out their suitability in Indian Agriculture. One of these was put to test and was found that three operations were necessary to separate the grains from weeds, chaff and other materials. It has also been observed that hand winnowing is necessary even after the third operation. It is estimated that the screen will be able to deliver 400 Lbs. of cleaned grain per hour and this output can be raised to 550 Lbs. if the screen is fed continuously. Some modifications of the screen are being contemplated and further trials will be continued.

EXPERIMENTS ON GROUNDNUT DECORTICATOR

Experiments were conducted on a hand operated groundnut decorticator, obtained from a firm in Bombay. These were in connection with finding out the optimum speed and any modifications to lessen the percentage breakage of kernels of the groundnuts. It was observed that there was appreciable breakage of kernels when the machine was worked by hand and this was improved by the introduction of rubber pads made of pieces of automobile tyre, on the drum with a working speed of 350 Revolutions per minute. In this case the machine was run by a 1/4 Horse Power electric motor with arrangements for varying the speeds. Later these rubber pads were replaced by 3/8" thick compressible type of rubber pads and was observed that percentage of broken kernels were reduced to 2·78% as against 5·07% by iron pads. It is learnt that rubber surface has been introduced in some of the rice hullers produced in Japan recently and has given better results in rice milling.

TRACTIVE EFFICIENCY OF FARM TRACTORS

A test of comparative tractive efficiency of two different farm tractors was carried out. One of them is a petrol tractor with wheel base of 70" and 20·7 Draw Bar Horse Power. The other one is a powerine tractor with a wheel base of 88-3/4" and 21·37 Draw Bar Horse Power.

The test was carried out in a ploughed land to pull a trailer with weights of approximately 3 tons. Both the tractors were tried in the first gear. The tractor with larger diameter wheels pulled the trailer while the other was unable to manoeuvre. From this fact it is gathered that the tractors with larger diameter wheels and with improved and deep treads are more efficient for farm operations, where the working in loose and wet soils without sliding or slipping of the wheels is necessary.

TRIALS OF DAVE'S SEED DRILL

The seed drill developed by Mr. Dave of Madhya Pradesh, was assembled and fitted on a local plough. During the trial it worked satisfactorily, the output being 1/4 acres of sowing in 75 minutes and the seed rate 41 seers of wheat per acre. The general performance of the seed drill was satisfactory, compared with ordinary seed tubes, used in conjunction with local ploughs for sowing. It is an improvement, as sowing by this machine is regular, the seed does not get bruised and there is saving of one man who would otherwise have to go with the ploughman dropping seed into the funnel. Incidently this seed drill mechanism also works satisfactorily for groundnut seeds without damaging the nuts.

A seed drill, based on the same principle but of different design, has been developed by Division is now awaiting field trials.

SEED DRILL FOR SMALL GRAINS

A 4-furrow seed drill has been built on the models of a machine designed in Lyallpur some time back. The machine drops the seeds in 4 rows at 8" apart and during tests it gave a seed rate of 18 seers per acre. As this seed rate was considered low, some modifications in the way of changing gear ratios have been carried out and is expected to give better results during the next trial. Apart from this, the general performance of the machine was found satisfactory. This drill is drawn by a pair of bullocks and is mounted on two wooden wheels. Most of the parts are built in wood, except the shafts and gears. The seed selector wheels are also made of wood, but require to be changed for each type and size of the grain.

JUTE SEED DRILL

The Head of the division of Agriculture Engineering visited the Jute Research Institute in Calcutta and had consultatious with the Director of the Institute regarding the development of jute seed drill. A seed drill on the Japanese model but with modifications has been sent to the Jute Research Institute for trial. A report containing suggestions for developing a jute seed drill has been submitted.

INDIAN COUNTRY IMPLEMENTS USED ALONG WITH A TRACTOR

The following Indian implements were hitched behind a Fordson Major tractor and worked satisfactorily :—

(*a*) The Bakhar :— The Bakhar worked up to a depth of 4". The length of the Bakhar blade used was 4'-0" with 5" width and 1/4" thickness. The outturn of work by the use of this blade was one acre per hour approximately during the trails.

(*b*) The Bund Former : – This implement has been developed by the Madras Agricultural Department and is very commonly used in the ceded districts of Madras for soil and water conservation. A Bund Former was fixed on the Cultivator frame-work and hitched behind a Fordson Major tractor for successful field operations. It can work in fields already ploughed. More than one Bund Former can be hitched to a time by a tractor.

TESTING OF IMPROVED GHANIS

At the instance of Indian Oil Seeds Committee, an improved model of Ghani was tested at Wardha and was found better than the existing country models. It had two ball bearings introduced on the moving beam and one thrust bearing at the top. The following are the performance data of the improved Ghani :—

1. Quantity of til seed used per charge	20 Lbs.
2. Time taken to crush the above	57 Minutes.
3. Number of rounds by bullocks per charge	250
4. Percentage extraction of oil (by weight)	45%
5. Rate of crushing	21 Lbs. per hour.
6. Average revolutions per minute of the bullocks	4·58
7. Distance of and weight on the arm	6'-0", 6 maunds.
8. Draft on the animal (single bullock)	125 Lbs.

TRIAL OF DISINTEGRATOR FOR CRUSHING BONE

A disintegrator was sent to this division by the Bone Meal Adviser to the Government of India for tests and demonstration. A two wheeled trailer was also made available from the Central Tractor Organisation for this purpose.

The disintegrator was mounted on the trailer and was worked by an Allis-Chalmer " B " tractor. The bones of small size were fed in to the hopper and they were crushed completely to bone dust. The output of finished bone meal was $1\frac{1}{4}$ tons per day of 8 hours. The tractor while operating this machine, consumed one gallon of kerosene (approximately) per hour. The cost of production is estimated to be about Rs. 37-0-0 per ton of crushed bone.

INTRODUCTION OF IMPROVED AGRICULTURAL IMPLEMENTS IN INDIA

At the instance of the Ministry of Food and Agriculture a note was prepared on the above subject. A quick method of improving and popularising agricultural implements in the different states of India is by introducing better implements of one region into another. To find out the better implements which deserve introduction in other states or popularising within the same state, it was necessary to collect information both from the State Governments as well as from the individual manufacturers of the agricultural implements within each State. From a survey of all available agricultural implements the following implements have been found fit for introduction and popularisation :—

1. Meston type mould board ploughs.
2. Bakhar or Blade Harrow.

3. Horse Hoe or Cultivator.
4. Mechanical seed drill.
5. Bullock drawn reapers.
6. Improved water lift.
7. Bullock gear for operating stationary machines.
8. Wet land puddler and green manure trampler.
9. Bund Former.
10. Cotton drill and clod crusher.

TRIAL OF BULLOCK DRAWN HARVESTING MACHINES

An improved type of bullock drawn reaper known as "The Viking Oil Bath Reaper Model D.O." was obtained from Messrs. Cossul and Co. Ltd. Kanpur for test and trial. This machine was, put into operation and was found to work satisfactorily. The special feature of this machine is that it has got a platform made of steel plate, which collects the harvested crops, instead of leaving them on the track to be cleared by human labour. The crops accumulated on the platform are cleared by one of the four rotating rakes and stacked on the field, off the track. Thus it enables to reduce the use of human labour which, otherwise is required in large number when ordinary mowing machines are used. Due to the additional fixture of the platform and the rakes, the machine is comparatively heavy and it has been observed that two pairs of bullocks at a time are necessary to get good results.

An Albion bullock drawn reaper, received from the Horticultural Department, was also put to work simultaneously with the Viking Oil Bath Reaper. The following are the results to the tests :—

Name of the machine	Men engaged including driver	Output per hour in acres	No. of pairs of bullock used
Viking Oil Bath Reaper Model D.O.	2	1·00	1
Do.	3	1·40	2
Albion Reaper	13	0·59	1

CONVERSION OF AN 'ARGADHA' TO MECHANICAL SEED DRILL

An 'Argadha' or indigenous seed drill of Madhya Pradesh has been converted into mechanical seed drill by mounting a seed dropping device on it. The driving arrangement has been made and is now awaiting trails in the field.

MANUFACTURE OF JAPANESE AGRICULTURAL MACHINES IN INDIA

At the instance of the Ministry of Food and Agriculture, the Head of the Division of Agricultural Engineering visited Central Rice Research Institute, Cuttack, to inspect some agricultural machines presented by the Japanese Ministry of Agriculture and to find out if it is possible to manufacture them in India. The machinery available in the Central Rice Research Institute were tried and some of them were found to be useful for Indian agriculture. The following machinery were recommended to be manufactured in India in the first instance :—

1. **Japanese pedal thresher for rice.**
2. **Japanese Power thresher for wheat and rice.**

3. Japanese hand sheller for paddy.
4. Japanese power sheller for paddy.
5. Japanese Rice Polisher.

A detailed report has been submitted to the Ministry.

TRIAL OF MILKING MACHINE

Two "Surge" milking machines were presented to the Institute by H. E. the Belgian Ambassador in India. This "surge" unit and a Massey Harris Milking machine, were tried on the cows of the Institute Dairy. The trials were inconclusive as the cows, being unused to the mechanical milking, did not give the usual yield of milk. The machines are in perfect condition and the experiments will be continued.

TEST OF PLOUGH SHARE CAPS

Two plough share caps designed by Messrs. Hadfield Needham Co., Ltd., Surrey, England, were sent for test trial by the Ministry of Food and Agriculture. These are made of chilled cast iron. These caps were fitted to the 2 and 4 furrow Massey Harris Ploughs, installed respectively to D4 and Second "E" Tractors. The life of these plough share caps has been found to be three or four on the Indian Agricultural Research Institute soil containing 6 to 8% moisture. The life of a steel plough share under the same soil conditions is approximately 20 hours in the first instance but this can be increased three-fold, thus giving it an extra working life of 40 hours i.e. a steel share can be worked for 60 hours in all. It has been observed during the trial that no wear and tear occurs on the steel shares, when the caps are put on. Actual extent of economy in using these caps can be worked out later.

A cap is fixed with a plough share by three bolts, one at the top and two at the bottom. These bolts very often get loosened and get lost during field operation. If a cap point comes in contact with hard soil after the top bolt is loosened, damage may be done to the plough bottom.

The caps could not be fitted properly with the T.N.T. plough. No other plough have been tried so far for fitting up these caps. The trials will be continued.

COST OF THRESHING BY DANISH THRESHERS

Costs of threshing operations by two threshers imported from Denmark, have been worked out. The small thresher was run by a 5-7 Horse Power Mobile Diesel Engine while the big one was worked by 28-9 Belt Horse Power Petrol Tractor, in the absence of suitable power unit. The following are the costs of operation of two threshers.

1. Big Thresher

(i) *Operating Cost.*

	Rs.	A.	P.
1. Cost of operating the 28-9 Belt Horse Power Petrol Type Tractor including depreciation, interest, fuel, driver and mate's wages lubricants and maintenance charges per day of 8 hours	31	8	4
2. Working costs of thresher including depreciation, interest, lubricants and mainterance per day of 8 hours	14	0	9
3. Cost of labour working with the thresher per day	8	12	0
Total ..	54	5	1

(ii) Cost per maund of threshed grain

Grain	Output in maunds per day.	Total cost per day in Rs.	Cost per maund in Rs.
Wheat	28·00	54·31	1·94
Peas	69·40	54·31	0·78

If the thresher had been run by a proper power unit of 6 to 8 Horse Power, the costs would be much less, i.e., they would be Rs. 1·305 and Rs. 0·526 respectively for wheat and peas per maund.

2. Small Thresher

(i) Operating Cost

	Rs.	A.	P.
1. Operating cost of 5-7 H.P. Diesel unit including, fuel, depreciation, interest, driver and mate's wages lubricants and maintenance etc. per day of 8 hours	13	12	0
2. Working costs of thresher per day of 8 hours including depreciation, interest, lubricants and maintenance	7	5	0
3. Labour cost per day	8	0	0
Total ..	29	1	0

(ii) Cost per maund of threshed grain

Grain	Output in mds. per day	Total cost in Rs. per day	Cost per md. in Rs.
Wheat	23·20	29·06	1·25
Barley	40·20	29·06	0·72
Oats	25·80	29·06	1·12

Notes ..

(*a*) Depreciation has been calculated on the basis on an anticipated working life of 3600 hours for the threshers and 8000 hours for the power units.

(*b*) Interest has been charged at the rate of 6% on half of the capital outlay.

INTENSIVE CULTIVATION

Threshing operations by a Disc and a Tractor :—

Threshing wheat at present is done in the rural areas by treading operation with bullocks. Threshing of wheat was tried by the Indian Agricultural Research Institute in the villages of Mundhka and Tikri under the intensive cultivation scheme, Delhi by using a disc harrow with a tractor. It was found that tractor disc used for threshing grain was quicker and also a cost saving operation, compared to the present method by bullocks. There was considerable interest aroused in the villagers in the work of threshing by a tractor disc and the work was done on a payment basis to some of

the villagers. The further advantage of tractor disc used for grain threshing is that the straw is completely cut to fine Bhusa, which is a better product compared to bullock threshing.

PROGRAMME OF WORK FOR THE YEAR 1951-52.

1. Determination of comparative costs of threshing small grains by different methods.
2. Experiments on spray irrigation set and costs of operations by the same.
3. Continued experiments on Japanese Agricultural machines and implements.
4. Operation of stationary machines by using a bullock gear.
5. Trials of Indian Indigenous water lifts and bullock operated pumps.
6. Investigations and experiments on mechanical harvesting and threshing of paddy.
7. A study and investigations of Agricultural implements suitable for introduction and popularisation in India.
8. Guidance and technical help to the manufacturers of agricultural implements in India, about designs of foreign implements which have worked successfully.
9. Collection of Indian indigenous implements for a Museum at the Indian Agricultural Research Institute.
10. Use of milking machines and economics of operation by the same.
11. Trial and testing of agricultural implements from abroad, particularly European countries.
12. Design and development of seed drills suitable for maize, peas, wheat, oats, barley, groundnuts and jute.
13. Investigations into the possibilities of screening manure at reduced costs.

PART III—APPENDICES

APPENDIX I—Gazetted Staff of the Institute

Director	Dr. J. N. Mukherjee, CBE., FNI., FRASB., FCS., (upto 15-9-1950).
	Dr. B. P. Pal, M.Sc., Ph. D. (Cantab), FLS., FBS, FNI., (from 16-9-1950).
Assistant Director	Dr. B. P. Lal, M. Sc., Ph. D. (Cantab), FLS, FBS, FNI. (upto 15-9-950) (at present vacant).
Registrar	Shri N. C. Pal, M.A., B.L. (upto 14-1-1951).
	Shri J. M. Banerjee, M.A. (from 15-1-1951).
Personal Assistant to the Director ..	Vacant since 15-1-1951.

Agronomy

Head of the Division	Dr. T. J. Mirchandani, M. Sc., Ph. D.
Agronomist	Dr. P. C. Raheja, M.Sc., Ph.D.
Agronomist	Dr. N. P. Datta, M. Sc., D.Sc.
Agronomist	Shri S. Sen, M.Sc.,
Assistant Agronomist	F/Lt. R. D. Verma, B. Sc., B. Sc. (Edin)
Assistant Agronomist	Dr. A. R. Khan, M. Sc., D. Sc.
Assistant Agronomist	Shri J. J. Chandnani, M. Sc. (Ag.).
Assistant Agrostologist	Shri P. M. Dabadghao, M. Sc.
Assistant Statistician	Shri P. N. Saxena, M.A.

Botany

Head of the Division	Dr. B. P. Pal, M.Sc., Ph.D. (Cantab), FLS, FNI. (upto 5-1-1951).
	Dr. N. Parthasarathy, B.Sc., B.A. (Ag.), Ph.D. (Lond.) (from 6-1-1951).
Geneticist	Dr. N. Parthasarathy, B.Sc., B.A. (Ag.), Ph. D. (Lond). (upto 5-1-1951).
	Shri R.B. Deshpande, M. Ag., Assoc. IARI. (from 6-1-1951).
Plant Physiologist	Dr. R. D. Asana, M.Sc., Ph.D. (Lond.), D.I.C.
Cytogeneticist	Dr. P. N. Bhanduri, M.Sc., Ph.D. (Lond.), FNI, FLS. FRMS., FBS.
Systematic Botanist	Dr. D. Chatterjee, M.Sc., Ph.D. (Edin.), FLS, FBS.
Assistant Geneticist	Shri R. B. Deshpande, M. Ag., Assoc. IARI, (upto, 5-1-1951). (At present vacant.)
Assistant Geneticist	Dr. F. H. Abbasi, B.Sc., Ph.D. (Minn.)

Asstt. Plant Physiologist	Shri T. J. Malkani, M.Sc.
Asstt. Cytogeneticist	Dr. A.B. Joshi, M.Sc., Ph. D. (Cantab), Assoc. IARI, FBS.
Asstt. Botanist	Shri H.B. Singh, M.Sc., Assoc. IARI.
Asstt. Economic Botanist	Dr. G. S. Murthy, M.Sc., Ph.D. (Minn.), Assoc. IARI.
Asstt. Wheat Breeder	Shri S. Sen, M.Sc. (from 6-1-1951).

SOIL SCIENCE AND AGRICULTURAL CHEMISTRY

Head of the Division	Dr. S. P. Raychaudhury, M.Sc., Ph.D. (Lond.), D.Sc. (Cal. & Lond.), FRIC.
Soil Microbiologist	Dr. S. V. Desai, B.Sc., Ph. D., D.Sc. (Lond.), DIC.
Soil Survey Officer	Dr. R.V. Tamhane, M.Sc., Ph. D. (Lond.)
Biochemist	Dr. N.B. Das, Ph. D.
Organic Chemist	Dr. K. C. Gulati, B.Sc. (Hons. Tech.), M.Sc. (Hons.) Ph. D.
Experimental Physicist	Dr. C. Dakshinamurthy, M.Sc., Ph. D., D. Sc.
Asstt. Soil Microbiologist	Dr. N. D. Vyas, M.Sc., Ph.D. (Nag.)
Asstt. Soil Survey Officer	Dr. K.V.S. Satyanarayanan, B.Sc. (Agri.), Ph. D., Assoc. IARI.
Asstt. Soil Survey Officer	Shri L. M. Mathur (Offg.), M.A., B.T., Astt.
Asstt. Organic Chemist	Dr. A. C. Bose, B. Sc. (Hons.), Ph.D., A.I.C. (Lond.)
Asstt. Organic Chemist	Vacant (from 22-3-1950).
Asstt. Soil Chemist	Dr. B. B. Roy, M.Sc., Ph.D., A.R.I.C. (Lond.)
Asstt. Soil Chemist	Dr. C. N. Acharya. (from 16-4-1951).
Asstt. Soil Physicist	Dr. B. T. Mulwani, (Offg.) B. Ag., M. Sc., Ph. D. (Lond.)
Asstt. Agricultural Chemist ..	Shri M. A. Idnani, B.Sc. (Hons.), Assoc., IARI.

Mycology

Head of the Division	Dr. R. S. Vasudeva, D.Sc. (Lond.), Ph. D. (Lond.) DIC., FNI.
Asstt. Systematic Mycologist ..	Dr. B. L. Chona, B.Sc., Ph.D., (Lond.), D.I.C. (Lond.)
Asstt. Plant Pathologist.	Dr. R. Prasada, M. Sc., D. Sc. (Agra.)
Asstt. Plant Pathologist	Dr. R. S. Mathur, M.Sc., Ph.D. (W. Va.), (from 1-12 1950).
Asstt. Virologist	Dr. S. P. Raychaudhury, M.Sc., D. Phil. (Cal.), FLS., Assoc. IARI., (On study leave).
Asstt. Plant Bacteriologist ..	Dr. M. K. Hingorani, B.Sc. (Agr.), Ph.D. (Minn.), Assoc. IARI.

ENTOMOLOGY

Head of the Division	Dr. E. S. Narayanan (Offg.), M.A., Ph. D. (Lond.), DIC., FRES.,
Systematic Entomologist	Dr. S. Mukherjee, M.Sc., D.Sc.

Insect Ecologist ..	.. Dr. S. Pradhan, M.Sc., Ph.D. (Lond.), D.Sc., FRES. FESI.
Asstt. Systematic Entomologist	.. Shri B. B. Bose, B.Sc.
Asstt. Syst. Entomologist ..	.. Shri C. K. Samuel, B.Sc., Assoc. IARI.
Asstt. Insect Epidemeologist	.. Dr. R. P. Chaudhury, M. Sc., Ph. D. (Lond.), (till 16-8-1951).
Asstt. Insect Physiologist ..	.. Dr. Rattan Lal, M.Sc., Ph.D.

AGRICULTURAL ENGINEERING

Head of the Division ..	.. Shri R. V. Ramiah, B.E. (Mech.), M.Sc., (AE.), M.A.S. A.E.
Assistant Engineer ..	.. Shri A. K. Kaul, I.E.E.
Assistant Engineer ..	.. Shri K.S. Chopra, A.M.M.E.A. (upto 4-12-1950).
Assistant Engineer ..	.. Shri J. S. Manku, B.Sc. (Elect. & Mech. Engg.) (from 9-5-1951).

AGRICULTURAL SUB-STATION, KARNAL

Assistant Agronomist ..	.. Shri B.D. Ganguly, B.Sc. (Ag.)

BOTANICAL SUB-STATION, PUSA (BIHAR)

Superintendent ..	.. Shri M. D. Nandkeolyar, M.Sc.
Assistant Wheat Breeder ..	.. Shri S. Kedarnath, M.A., M.Sc. (from 8-2-1951).

CO-ORDINATED WHEAT RUST CONTROL SCHEME, SIMLA

Assistant Wheat Breeder ..	.. Dr. S. Kohli, M. Sc., Ph, D. (Cornell) (from 30-3-1951).

APPENDIX II—TRAINING OF STUDENTS AND RESEARCH WORKERS

(a) List of students awarded Post-Graduate Diploma.

Name of students	Thesis
	AGRICULTURE
1. Arun Kumar Mukherjee..	.. Effect of bhusa buried with artificial fertilizers on the yield of wheat.
2. Autar Singh	.. Varietal-cum-manurial trial with Linseed.
3. Balkrishna Hari Patel ..	.. Response of different varieties of wheat to different doses of nitrogen and sowing dates treatments.
4. Baleswar Prasad Singh	.. Cultural-cum-manurial experiment on cane.
5. Daya Krishna Misra ..	.. Indirect and direct manuring of cereals in rotation with berseem.
6. Ganpat Singh Shankhla	.. Cultural experiment with gram.
7. Gokran Nath Misra ..	.. Residual effect of depth of cultivation, time of application of nitrogen and placement of phosphate on cane.

(AGRICULTURE—*contd.*)

8. Inderjit Lal Malhotra ..	Effect of manuring of berseem in a Maize-Cotton rotation.
9. Jagannath Ramchandra Kakde ..	Studies of the effect of different fertilizers on the associated growth of cereals and legumes.
10. Krishna Chandra Misra ..	Cultural-cum-manurial experiment with potatoes.
11. Laxmen Bakaram Lanjewar ..	Comparative performance of cane varieties.
12. Madhusuda Shridhar Joshi ..	Ley farming—seed mixture trials.
13. Naraindas Wadhwa	Cultural experiment on Phalaris minor.
14. Nilambar Mukherjee	Ratooning capabalities of various cane varieties.
15. Qdam Singh Dhaka	To study the effect of mixed cropping on yield.
16. R. Gurbasavaraj	Phosphate manuring of berseem. Effect of B, and M. singly and in combination.
17. Satya Ranjan Roy	Effect of sannhemp, green manure, as applied in different forms in combination with fertilizers on the yield of wheat in G.M., Wheat, maize rotation.
18. Shyam Monohar Tripathi ..	Varietal trial with wheat (N.P. and Punjab varieties.)
19. Vasdev Tejumal Motwani ..	Building up of soil fertility by phosphate manuring of berseem in a green manure rotation (Series III).

BOTANY

20. D. G. Gupte	A study of the relation between tillering, earning and seed setting capacity in wheat.
21. K. K. Pande	Studies in autotetraploids of linseed.
22. K. N. Singh Gahlot	Studies in drought resistance in wheat.
23. J. P. Srivastava	Inheritance studies in some species crosses in *Linum*.
24. R. N. Srivastava	Studies in autotetraploids of gram.
25. P. Sanyal	Cytogenetical studies of " Triticale " intervarietal wheat hybrids and different varieties of secale *cereale*.
26. P. K. Kaushal	Cytogenetical studies of *Triticum*, *Agropyron* and *Aegilops* species and hybrids.
27. P. S. Srivastava	A study of the factors concerned in the lodging of wheat.
28. N. H. V. Krishnamurty ..	Inheritance studies in wheat : Variability of certain characters such as strength of straw, test weight, awnedness, length of the ear, number of spikelts and grains per ear and density of the ear as a basis for the study of their inheritance.
29. S. C. S. Mann	Do. (The characters chosen for the study of inheritance and the varieties selected for such studies will be different in case of each student).

30. S. S. Venkata Rao .. .. Study on the Crossability of different wheat species and varieties.

31. S. P. Mital .. .. .. Studies in :
(*i*) Non-tuberiferous species and hybrids of *Solanum*.
(*ii*) Flowering, fruiting and crossing behaviour of *Lycopersicon* species.

32. S. Ramanujam .. .. Study of hair character in wheat species and varieties as an aid to classification.

33. S. C. Nag Biswas. .. .. Cytotaxonomical studies in sweet potato.

CHEMISTRY

34. A. Sankaran .. .. .. Preparation of reconnaissance Soil map of the Northern Part of the Delhi Province.

35. B. B. Rudra .. .. .. Chemical, Electro-chemical and Minerological studies of clay fractions of Delhi and Karnal Soil Profiles.

36. B. R. Gangwar .. .. Preparation of Soil map of Karnal Farm.

37. B. S. Gupta .. .. .. Preparation of Soil map of I.A.R.I. Farm.

38. A.S. Verma .. .. .. Food value of maize (from the permanent manurial experiments at Pusa) as reflected by manurial treatments.

39. R. D. Tripathi .. .. Preparation of reconnaissance soil map of the Southern part of the Delhi Province.

40. T. L. Deshpande .. .. Study of black soils of Narbadda Valley.

41. S. D. Sinha .. .. .. On the nature of a black soil from Padegaon, Bombay.

ENTOMOLOGY

42. G. K. Nair .. .. .. Constitution of insect epicuticle in relationship to insecticidal action.

43. S. S. Mundar .. .. Effect of Concentration on temperature Co-efficient of DDT action.

44. B. R. Subba Rao .. .. Effect of different alternate hosts upon the parasites.

45. H. J. Bhambani .. .. Studies on fumigation under partial pressures.

46. M. G. Jotwani .. .. Bioassay of some important insecticides as stomach poison against some insect pests.

47. A. N. Chowdhury .. .. Effect of temperature and humidities on the incidence of top-borer *Scirpophaga nivella*.

MYCOLOGY

48. C. R. Das .. .. .. Further studies on mosaic disease of sannhemp (*Crotalaria juncea* Linn.)

49. D. P. Singh .. .. .. Comparative cultural and pathogenic tests of species of *Collectotrichum* occurring on Graminar.

50. D. S. Malla .. .. .. Bacterial soft-rot of vegetables in Delhi Markets.

51. Gopal Swarup .. .. Fungud flora of stored seed grains its correlation to seed rotting and pre-emergence injuries and the beneficial effect of fungicidal treatment.

52. H. C. Arya ..	*Alternaria* blight of linseed.
53. K. L. Maheshwari ..	Linseed wilt.
54. K. G. Neema	Inhibitory effect of soil micro-organisms on *Fusarium udum*, the pigeonpea Wilt organism.
55. K. G. Shahare	Mosaic disease of *Urid* (*Phaseolus mungo* Linn.).
56. M. Hanumantha Rao	Leaf spot of tobacco.

(5) *Students admitted during the year.*

AGRONOMY

1. Gursharan Lal Luthra.
2. Jagdish Chandra Sharma.
3. Mewa Ram Bajpai.
4. Ravindra Nath Kaul.
5. Surendra Singh Chauhan.
6. Ram Dayal Singh.
7. Kailash Prashad Gupta.
8. Dharam Pal Singh Teotia.
9. Shiv Sagar Singh.
10. Rajendra Pal Singh.
11. Om Prakash Awasthi.
12. Madhao Ganesh Kelkar.
13. Vasant Rambhan Raparekar.
14. Namdeo Tukaram Badhe.
15. Prabhakar Sheshrao Mahalle.
16. Kamal Singh Cheema.
17. Bhami ni Bhusan Bose.
18. Bishwajit Choudhury.
19. Rangadhar Satpathi.
20. Asoke Kumer Das Gupta.
21. Narayanrao Tukaramji Sarnaik.
22. Om Prakash Mathur.
23. Guru Charan Singh Sekhon.
24. Netra Bahadur Basuyat.
25. Aniruddha Misra.

BOTANY

26. Shambhoo Dayal Choubey.
27. Shridhar Madharao Vaidya.
28. Ram Gopal.
29. Dattaraya Kashinath Vedpathak.
30. Madhav Ganesh Joshi.

31. Yog Raj Ahuja.
32. Charanjit Lal Dhawan.
33. Hemanta Kumar Mohanti.
34. Kamal Prasad Sharma.
35. Satish Chandra Pokhriyal.
36. Anandrao Rambhu Moon.
37. K. Abdur Rahim Khan.
38. George Harris Maduram.

Chemistry

39. Yash Paul Bali.
40. Nanak Saran Sinha.
41. Bal Govind Misra.
42. Janardan Jha.
43. Kali Kant Jha.
44. Awadh Bihari Lal.
45. Vasudeo Gopalrao Wahurjkar.
46. Prabhakar Mahadeo Tambali.
47. T. R. Srinivasan.

Physics

48. Shri Krishna Prasad.
49. Ejazul Haque.
50. Mohd. Imran.
51. Abdullah Khan.
52. S. Seetha Raman.
53. Ram Avtar Agarwal.
54. Jagamohan Satpathy.
55. D'Souza George Irawana.
56. Vikram Govind Prasad.

Mycology

57. Aiyabhai Jivaji Harbi.
58. M. A. Venkataraman.
59. K. P. Sreekumar.
60. A. K. Nagpal.
61. Kandagadu Chennaiah.
62. Sat Pal Singh.
63. Prem Prasad Mehta.
64. Durga Das Srivastava.

(*c*) *Students admitted for short course training during the year.*

ENTOMOLOGY

1. N. S. A. Raman.
2. K.C. Jain

BOTANY

1. R. K. Mehta.

CHEMISTRY

1. C. R. Venkataraman.
2. S. P. Gupta.
3. Devendra Sharma.
4. K. L. Bhagat.
5. Newton Ram.
6. Anup Singh Saudhu.
7. M. P. Sankaranarayanam.
8. T. A. Govind Iyer.
9. J. C. Bhattacharya.
10. R. C. Das.
11. B. K. Patnaik.
12. C. M. Mathur.

(*d*) *Honorary Research Workers.*

AGRONOMY

1. H. Gurubasavaraj.
2. V. J. Lokraj.

BOTANY

1. Shivcharan Singh Mann.
2. Kamala Kant Pande.

CHEMISTRY

1. I. D. Dharni.
2. A. K. Das.
3. R. K. Chatterjee.
4. D. J. Gupta.

ENTOMOLOGY

1. S. Krishnaswami.
2. Mrs. M. Jasudason.

APPENDIX III—List of Publications Published during 1950 51

Asana, R.D. and Mani, V.S.	(1951)	Some observations on the growth of plants raised from punctured wheat grains. *Proc. Indian Sci. Congr.* pt. 4 ; 30.
Asana, R.D. and Mani, V.S.	(1951)	Observations on the influence of indoleacetic acid on the growth of three varieties of wheat. *Proc. Indian Sci. Congr.* pt. 4 ; 31.
Chatterjee, D.	(1949)	Three new plants from Sikkim and Burma. *Bull, Bot. Soc. Bengal* **3** : 17-19.
Chatterjee, D.	(1950)	Cow tree *Science and Culture* **16** : 116.
Chandani, J .J	(1951)	Things to do on the farm during the month of May ; June and July and August. *Indian Fmg.* N. S. **1(1)** :7; **1 (3)** : 8-9 ; **1 (4)** ; 6.
Chona, B. L. and Ramlal Munjlal.	(1950)	Notes on miscellaneous Indian fungi. *Indian Phytopath.* **3** : 105-16.
Chona, B. L. and Hingorani, M.K.	(1950)	Comparative studies of certain isolates of *Colleloirichum falcatum* Went. *Indian Phytopath.* **3** : 196-202.
Dabadghao, P . M. ..	(1951)	All flesh is grass. *Indian Fmg.* N.S. **1 (3)** : 20-21.
Das, N. B.	(1951)	Food value of mango seed Kernel. Pamphlet published by the All India Women's Food Council, Jamnagar House, New Delhi.
Desai, S. V. and Subbiah, B.V.	(1951)	Nitrification in relation to cation absorption by plants. *Proc. Indian Acad. Sci.* **34** : Sec. B ; 73-80.
Desai, S. V. and Sen Abhiswar	(1951)	Influence of climate on the salinity of Indian Soils *Proc. Indian Sci. Congr.* pt. 4 ; 35.
Desai, S. V. and Sen, Abhiswar. ..	(1951)	Occurrence of Sodium chloride in Indian Soils. *Proc. Indian Sci. Congr.* pt. 4 ; 35.
Deshmukh, M. J. and Pal, B. P. ..	(1950)	A note on the tetraploid of *Nicotiana glanca. Indian J. Genet. Pl. Breed* **10** : 72-77.
Deshpande, R. B. ..	(1950)	*Hibiscus sabdariffa* L.—a promising fibre plant. *Science and Culture* **16** : 237-240.
Gattani, M.L.	1950)	The quantitative determination of moulds in Sweet potato and Wheat flour. *Indian Phytopath.* **3** : 148-152.
Gulati, K. C. and Bharat Bhusan	(1951)	Studies in Indian turpentine ; Part IX—Preliminary experiments on hydroxylation of higher fractions. *Proc. Indian Sci. Congr. pt* 3, 102.
Idnani, M.A.	(1951)	Human Urine—an unexploited source of manure. *Indian Fmg.* N. S. **1(3)** : 22-23.

Kedarnath, S. (1950) A note on the chromosome numbers of some plants. *Indian J. Genet. P Breed.* **10** : 96.

Khan, A.R. .. .. (1951) Irrigation—small scale. *Indian Fmg.* N. S *1* (**1** & **2**) 27-29.

Mukerji, S. .. .. (1950) On a new species of *Phytophagous Chalcidoidea, Megastigmus albizzae* sp. n. feeding on *Albizzia odoratissima* pods in the environs of Delhi. Proc. Roy. ent. Soc. Lond. (B) **19** : 129-132.

Mukerji, S. .. .. (1951) A new accessory structure to the ovipositor to aid oviposition and boring in a parasitic Scelinoid (*Hamenoptera* : *Proctotrypoidea*). *Curr. Sci.* **20** :166.

Mukerji, S. and Chatterji, S. N. (1950) *Diaeretus aphidum* sp. n. (*Hymenoptera* : *Aphidiidae*) a parasite of *Pterochlorus pertsicae* Cholod. on *Prunus persica* in Beluchistan. *Proc. Roy.* ent. Soc. Lond. (B) **19** : 4-6.

Mukerji, S. and Chatterji, S.N. (1951) Morphology of the genital structures of some of the *Bruchidae* (*Lariidae*) of India and Ceylon and their toxonomic importance. *Indian J. ent.* **13**: 1-28.

Mukerji, S. and Singh, Kukum .. .. (1951) Studies on the chaetotaxy of larvae of *Pulsia* species (*Lepidoptera* : *Phalaenidae*). *Proc. Roy. ent. Soc. Lond.* (*B*) **20** : 15-24.

Narayanan, E. S. and Samuel, C. K. .. (1951) The Kutra hairy caterpillar and its control (Pamphlet in Hindi for the benefit of cultivators in the neighbourhood of Delhi) Published by the Department of Agriculture, Delhi State, Delhi.

Narayanan, E.S. and Subba Rao, B. R. (1951) Studies in insect parasitism. The effect of different hosts on the physiology of the parasite *Bracon gelechiae* Ashmed, a larval parasite of the potato tuber moth *Gnorimoschima operculella*. *Proc. Indian Sci. Congr.* pt. 4 : 26.

Pal, B. P. .. .. (1951) New wheats for old. *Indian Fmg.* N. S. **1** (**1** & **2**) : 12-13, 22-23 and 27.

Pal, B. P. .. .. (1951) Introduction of wild elements for the improvement of wheat. *Indian J. Genet. Pl. Breed.* **11** : 23-28.

Pal, B. P. and Mukherji, D. K. .. (1950) Seed testing. *Science and Culture* **16** : 43-51.

Pal, B. P. and Pushkarnath .. .. (1951) Potato breeding investigation in India. *Emp. J. exp. Agric.* **19** : 87-103.

Pal, B. P. and Pushkarnath .. .. (1951) Indian Potatoe varieties. Bulletin No. 62. Indian Council of Agricultural Research 1-63 pp. 12 plates. Manager of Publications, Civil Lines, Delhi.

Pradhan, S. and Bhatia, S. C. .. .. (1950) Specific susceptibility to HCN and the amount of HCN recovered from fumigated insects. *Bull. ent. Res.* **42** 399-418.

Pradhan, S. and Bhatia, S. C. .. .. (1951) Laboratory trials of synthetic insecticides as contact poison against insect pests. **Part I.** *Proc. Indian Sci. Congr.* pt. 4 ; 33.

Pradhan, S. and Jotwani, M. G. .. (1951) Bioassay of Stomach poisons. *Proc. Indian Soi. Congr.* pt. 3 ; 219.

Pradhan, S. and Mundkur, S. S. .. (1951) Temperature co-efficient of D.T.T. action on mosquito larvae (*Culex fatigans*) *Proc. Indian Sci. Congr.* pt. 3 ; 220.

Pradhan, S. and Nair, G. K. .. .. (1951) Insect epicuticle in relation to action of insecticides *Proc. Indian Sci. Congr.* pt. 3 ; 218.

Pradhan, S. and Srivastava, H. M. L. .. (1951) Physical performance of a laboratory dusting apparatus. *Proc. Indian Sci. Congr.* pt. 4 ; 32.

Pradhan, S. and Srivastava, H. M. L. .. (1951) Effect of temperature on toxicity of insecticide dusts. *Proc. Indian Sci. Congr.* pt. 4 ; 34.

Pradhan, S. and Srivastava H. M. L. .. (1951) Effect of particle size on toxicity of insecticide dust. *Proc. Indian Sci. Congr.* pt. 4 ; 34.

Prasada, R. and Goswami, T. K. .. .. (1950) Studies in clover rust, *Uromyces trifolii* (Hedus. f.) Lev. in India. *Indian Phytopath* **3** : 191-95.

Prasada R. and Tandon I. N. .. .. (1950) Leaf spot disease of oats and its control. *Indian Phytopath.* **3** : 87-94.

Raychaudhury, S. P. .. (1951) Indian soil and its conservation. *Science and Culture* **16** : 286-89.

Raychaudhury, S. P. .. (1950) Red and lateritic soils of India. *Trans. Fourth. internat. Congr. Soil Sci. Amsterdam* ; **3** : 128-31.

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Raychaudhury, S. P. and Sankaram, A. .. (1951) A reconnaissance soil survey in the Jumna Khadar Area (North) of the Delhi Province, *Proc. Indian. Sci. Congr.* pt. 4 ; 26.

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Ramanujam, S. ..	.. (1950)	Lodging in cereals and possibilities of breeding for resistance. *Indian. J. Genet. Pl. Breed.* **10** : 78-95.
Rattanlal ..	.. (1948)	Biological observations on *Creontiades pallidifer* walk (*Megacoelum stramineum* Walk.) with notes on various insect pests found on potato at Delhi. *Indian J. Ent.* **10** : 267-78.
Rattanlal ..	.. (1949)	A note on the field trials of DDT on potato crop against *Empoasca Kerri* var. *motti* Pruthi, *Creontiades pallidifer* Walk. and *Myzus persicae* Sulz. *Indian J. Ent.* **11** : 17-24.
Rattanlal ..	.. (1949)	Control of *Creontiades pallidifer* Walk, with DDT. *Indian J. Ent.* **11** : 209-13.
Rattanlal ..	.. (1950)	Further notes on the life-history of *Empoasca Kerri* var. *motti* Pruthi and on the nature and extent of injury to potato foliage. *Indian J. Ent.* **12** : 31-37.
Roy, B. B. ..	.. (1951)	Clay constituents of some Indian soils. *Indian Soc. Soil Sci.* Bull. No. 6 ; 121-123.
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Tamhane, R. V. ..	... (1950)	Regur soils of India. *Trans. fourth internat. Congr. Soil. Sci. Amsterdam* : **3** : 131-34.
Tamhane, R. V. ..	.. (1951)	A note on rice cultivation in Australia *Rural India* **14** : *193-95.*
Vyas, N. D. ..	.. (1951)	Manurial value of sunnhemp seeds. *Proc. Indian Sci. Congr.* pt. 4 ; 21.

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